

The Blast Furnace and Steel Plant

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The Blast Furnace *and* Steel Plant

Vol. XV

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No. 12

A Christmas Suggestion

THE real significance as we see it of serving a mammoth industry, such as reflected in the relations of the steel industry to the business structure of America, is that of seriously realizing the responsibilities which are ours. That responsibility is not held lightly. Extending over a period of years Blast Furnace & Steel Plant has been the accepted technical journal with a special appeal to executives and others in charge of plant production and operations,—even to those in more lowly positions, aspiring and eventually reaching important places. Each month a variety of special articles written by authorities, bearing on furnaces and mill practices have contributed to broadening the knowledge of those directing the operations of steel plants.

Possibly at no time in its history has Blast Furnace & Steel Plant been so ably edited, the editors being practical steel men, having at some period in their careers, managed various departments in the industry. They are assisted by an Advisory Board comprised of eminent men actively engaged in various steel plants.

Blast Furnace & Steel Plant is interested in spreading its usefulness. There are hundreds of progressive young men filling minor positions in various steel plants who should—through an educational process, be fitting themselves for greater responsibilities in the future. There is no better means of getting practical information, than by reading a publication wholly devoted to one purpose—i.e.: analyzing the many every day problems and presenting the latest developments in new methods.

No doubt you know of one or more such young men. They may be located in the steel districts of Pittsburgh, Youngstown, Chicago, Colorado, Alabama, Canada, Germany, Belgium, Japan, England, France, or elsewhere. Assuredly they would appreciate having the opportunity of mentally equipping themselves for greater work in their chosen field of endeavor.

Can you imagine a more significant and seasonable Christmas present than sending Blast Furnace & Steel Plant for one year to a worthy person or friend. Isn't the suggestion worthwhile and may we add, that this is possible at \$2.00 per year, (foreign subscriptions \$3.50; Canada \$2.50). With each order received a suitable card will be mailed advising to whom thanks are due. A good deed brings its own reward.

Iron and Steel Division of A.S.M.E. Meets

Initial Meeting of Newly Formed Branch Exceeds Expectations
in Attendance and in Display of Enthusiasm—Two Papers
Presented—Schwab and Campbell Speak at Dinner

By CHARLES LONGENECKER

ABOUT 800 steel plant engineers gathered in Youngstown, on November 10, to attend the one day session of the Iron and Steel Division of the American Society of Mechanical Engineers. The meeting, although sponsored by the A.S.M.E., received the co-operation of the Buffalo and Cleveland Engineering Societies, the Engineering Society of Western Pennsylvania, the Lehigh Engineers Club and the Technical Federation of Erie.

Probably the best criterion as to the interest evoked in this meeting was the large attendance. At the morning session the room in which the papers were delivered was filled while it was necessary to provide overflow accommodations for many of those who desired to attend the dinner.

Two papers were read at the technical session, which was presided over by Mr. E. T. McCleary, vice president of the Youngstown Steel & Tube Company. The one by Mr. S. M. Phelps, director of Research and Tests Refractory Fellowship, Mellon Institute, touched on the "Future Progress in the Field of Refractories" and that by Mr. F. C. Biggert, Jr., president, United Engineering and Foundry Company, covered the development of four-high rolling mills. The former paper was discussed by O. H. Davison of the United States Refractories Company, Mr. G. G. Coolidge of the Harbison-Walker Company, Mr. M. J. Terman of the Babcock & Wilcox Company, and by Mr. Alexander Dow of the Detroit Edison Company. The second paper, that by Mr. Biggert, was especially pertinent as it treated a subject of especial interest to engineers at this time. Discussions on this paper were by Mr. Lloyd Jones of the E. W. Bliss Company and by R. J. Wean of the Aetna-Standard Engineering Company. Both Mr. Phelps and Mr. Biggert's papers, with the discussions, are published on the following pages.

Inspection tours of local plants were taken during the afternoon. These included trips to the plants of the Youngstown Sheet & Tube Company, the Republic Iron & Steel Company, the Truscon Steel Company, the Carnegie Steel Company, Ohio Works, the General Fireproofing Company, and the Trumbull Steel Company. Much interest was manifested in the new Pilger Mill at the Campbell plant of the Youngstown Sheet & Tube Company. Many also visited the Trumbull Steel Company to see the recently installed four-high strip mill.

The dinner which was held in the Hotel Ohio, besides being exceptionally well attended proved to be a most enjoyable event. Mr. C. S. Robinson, vice president of the Youngstown Sheet & Tube Company, as toastmaster, in his opening remarks called attention to the standing of Youngstown as a producer of iron and steel products. He referred to the word Youngstown as "synonymous with quality and service." Mr. Robinson then read letters from Mr. Joseph T. Butler, and Mr. E. J. Buffington, and a telegram from James A. Farrell expressing regret that

they were not able to attend the meeting. James A. Campbell, president of the Youngstown Steel & Tube Company, was the first speaker. In his address Mr. Campbell mingled humor with seriousness. He impressed upon engineers the responsibility that was theirs in carrying to successful completion the many projects intrusted to them. Mr. Campbell then stated that it was the policy of his company to secure the services of engineers, who were specialists in their work, to assist the chief engineer in any particularly large undertaking. This they had done in designing the Pilger mill and the most recent power plant.

Mr. Charles Schwab, the second speaker, was accorded a most hearty welcome. While Mr. Schwab's remarks were as usual of a humorous nature he did not let pass the opportunity to emphasize the beneficial effects of good fellowship and co-operation. His fund of stories appeared to be inexhaustible and was lavishly drawn upon to the enjoyment of his audience. Mr. Schwab stated that in his coming address before the American Society of Mechanical Engineers, in December, his subject would be "Human Engineering" and that he was going to do all in his power to increase interest in this phase of steel plant operation.

Alexander Dow, president of the society and of the Detroit Edison Company, followed Mr. Schwab. He dwelt upon the problems that confront the public service corporations, especially in relation to the output which may be expected per man. He prophesied that we were approaching a limit in output per man and that in coming years foreign competition would become greater as we approached this limit.

The executive committee appointed for the iron and steel division of the society will be made up of F. C. Biggert, Jr., president, the United Engineering and Foundry Company; George C. Snyder, chief engineer, the National Tube Company; W. W. Mason, managing editor, "Iron Age;" and C. S. Robinson, vice president, the Youngstown Sheet & Tube Company.

Future Progress in the Field of Refractories

By Stuart M. Phelps

Refractories are of such vital importance in the iron and steel industry that any subject matter which tends to increase their service ability to this industry is of interest and value. Consequently, considerable has been written on this subject in a general way. This paper, however, general as it is, directs attention along two avenues, which it is believed will lead most directly to the progress that is to take place in the future.

Progress has resulted in all branches of industry as a result of co-ordination of knowledge and experience in a systematic or scientific manner. Producers and consumers co-operate to their mutual interests in extending the usefulness of commodities. There has

not been developed, however, the necessary relationship between the manufacturer and user of refractories to affect the progress that is to be desired in this field.

The whole problem of advancement in the utility of refractories is of such a complicated and obscure nature that at times it appears hopeless. The manufacturer or user cannot solve the problem alone and it is only through the closest co-operation and critical study by each group that significant progress can be made.

One of the two means of accomplishing this aim is by interesting the user in the value resulting from his study of refractory problems. Provided he will become more familiar with the properties and limitations of refractories and apply this knowledge in a critical study of specific conditions in service, the information gained will be of great value to the consumer and producer as well. Such fundamental information is essential for progress, and although it cannot be obtained in a short period, the start must be made so that one type of service after another may be benefited.

The second means of advancement will be through the manufacturer obtaining these service data and developing his material so as to furnish properties that will meet the service conditions to the greatest possible degree.

Progress in either direction will necessarily be slow. A factor is the low cost of refractories per ton of finished material, and, consequently, the consumer may not be as deeply concerned with this problem as with others. Increased efficiency in all branches of industry has, however, had its effect on the refractories used in furnace operations. Years ago fire brick were purchased on the recommendation of the head bricklayer. During this period many of the brick used were found to be satisfactory by reason of the social or business relation between the head bricklayer and the refractories salesman. If brick were tried contrary to the bricklayer's wishes, they could readily be mistreated in service and thereby eliminated. Succeeding this period is that of buying by the purchasing agent, but here, too, progress is retarded in another manner.

The purchasing agent's objective is to buy refractories at the lowest possible price and the suitability of the brick bought is often secondary. Such a means of buying may or may not prove to be economical. If all refractory materials possessed the same properties to the same degree, such a system would be efficient and practical.

Maximum life of the refractories under a given set of conditions in service will be obtained only by employing brick that have the specific properties essential for that service. It is logical, therefore, to consider the properties of the brick that are to be purchased. This resolves itself into the use of specifications, which should be an effective means of buying refractories. Experiences with specifications to date, however, have not always been satisfactory and a little thought will reveal the cause of this condition.

A practical and valuable specification must set forth requirements for the brick that will allow it to render the maximum practical life in the position in which it is to be used. In order to make it practical, however, the requirements must be such that materials can be manufactured so as to meet them and sell at a price satisfactory to both parties. There are definite limitations to the development and combinations

of properties that can be made in any refractory product. As a result of these conditions, most specifications now in use are of more or less questionable value. As progress is made in the study of service conditions and as more adequate test methods are developed, it will be possible to formulate specifications that will be invaluable. Aside from their value to the consumer, they will stimulate the development of special refractories to fulfill the requirements set forth. It is unreasonable to expect the manufacturer to extend his interest in research or the development of his product beyond a certain degree, without an appreciation or demand for them.

At the present time it is possible to formulate specifications for most furnace operations that will be of considerable value in spite of their shortcomings. They will offer a means of eliminating in a definite way the types of brick that are unsuitable for the service and leave a group that offer the best possibilities. In order to determine the most suitable brand in this eligible group for the service it is necessary to conduct service trials thereby, selecting by elimination.

In order to formulate a specification of merit, it is essential that the most experienced technicians of the consuming and producing interests co-operate to supply the information that is vital for its success.

In connection with specifications, there should be mentioned the influence that they exert on the trade in general. It will mean that the same language concerning service conditions and operations, properties of refractories and test methods will be used by all. They will set down a definite scientific outline of the refractories problem in each type of service and will supply a clearly defined procedure for the manufacturer to follow. The development of the refractories field to such a scientific and organized basis should be one of the greatest periods in its history of progress.

Another means of increasing the utility of refractories is in the method of their use. Invariably the furnace design and its operation are decided upon without due consideration of the limitations and properties of the available refractories. In the recent meeting of the Fuels Division of the Society, the writer presented a paper* showing the relation between conditions of service and properties of refractories. Great advancement can be accomplished in this direction by the consumer assisted by the producer. The correcting of such conditions undoubtedly offers a greater field for progress than does the development of novel refractory materials.

In considering the development of the refractories themselves, the question of demand is basic. As mentioned, the enumeration of specific logical requirements by the consumer will largely influence the rate of progress. At present it is difficult to determine and weigh the importance of certain properties in the various types of service. There is also the question of the sale price of the brick when developed. Considerable difference in opinion exists as to the price that can be paid for brick that will increase the average service period. Will it be of interest financially to the producer to develop such superior products?

Steady progress is being made in all branches of the production in the way of raw materials, methods

*"Properties of Refractories and their Relation to Conditions in Service," presented at the First National Meeting of the A.S.M.E. Fuels Division, St. Louis, Mo., October 10 to 13, 1927.

of forming and in firing. The replacement by machinery of the human element is an important factor in producing more uniform brick. In the firing process the uniformity is being assisted through the application of data obtained in careful studies of kiln firing. The adoption of tunnel kilns is also a noteworthy factor.

The following comments regarding the various classes of refractory possibilities for advancement are given, some of which may not prove practical upon application.

Clay Refractories

Clay refractories are usually made of a mixture of flint and plastic clays. A wide range of properties can usually be obtained by blending various percentages of these clays. In addition to such mixtures various methods of manufacturing are employed to produce desirable characteristics in the brick.

The immediate outlook for improved clays does not appear promising. Mention should be made, however, of the opportunity of purifying clays for use in manufacturing blast furnace brick. The iron compounds present in nearly all suitable refractory clays are believed to be one cause of the disintegration occurring in these linings. Clays are treated for use in manufacturing glass-house refractories and many of the other ceramic industries employ processes for purification, such as weathering, washing, elutriation and magnetic separation.

The chemical composition of the various clays used in the brick must be of importance to their behavior in service. For instance, if clays are employed in a brick mixture that vary widely in the silica-alumina ratio and total percentage of fluxes, there will be, in the heat treatment of service, various chemical reactions occurring in these dissimilar constituents. A refractory cannot be expected to maintain its original properties in service under such conditions existing within the brick. Obviously dissimilar physical properties of the ingredients will have like effects. Such reasoning applies to all types of refractories and is not limited to clay refractories.

Another field of possible improvement is that of the control of the percentage of the various particle sizes of the materials used in compounding the bath. A study of this subject is now in progress† and preliminary data appear to be of value. It is well known by practical brick men that the structure of the brick is often more important than the chemical composition or resistance to heat. The structure of the finished refractory is not only dependent upon the process of manufacturing, but also upon the physical and chemical characteristics of the materials employed in compounding. Therefore, studies of the effect of calcined flint or plastic clay upon the brick should be conducted.

There are innumerable fields for investigation along such lines that will probably result in greater progress in the production of more useful refractories than will the employment of new raw materials.

Silica Brick

The noteworthy innovation in recent years concerning silica brick is the adoption of the silica brick machine in their manufacture. Such mechanical mold-

ing of the brick should be an important factor in the production of more uniform brick. Evidently the properties of such brick are equal to the hand made product and should be superior for obvious reasons.

Another aid to the production of a highly uniform product would be to fire them in continuous kilns. This method of firing is now being seriously considered and will undoubtedly be employed in the near future.

Since silica brick are made of about 98 per cent ganister, it is necessary to bond the silica grains together in order to obtain the necessary strength and structure. Furthermore, the quartz or ganister must be converted into another physical form to prevent excessive spalling and expansion in service and this requires a flux or catalyzer. At the present time lime is used in all silica brick, but investigators have tried from time to time a large number of other agents for this purpose. So far no novel materials have been employed commercially. The two per cent of lime which was employed in the earliest days of silica brick manufacture is as yet the most satisfactory for silica brick.

A fruitful field for development of these refractories should be that of producing a dense silica brick. Such a brick would be a better heat conductor for muffles, coke oven walls, regenerators and such types of service, as well as being more resistant to most types of slag action.

Diaspore Refractories

The high alumina content of the diaspore refractories make them resistant to unusually high temperatures. This fact, along with their chemical nature make them of particular value for a number of service conditions. Their utility can be extended, however, by minimizing their probable shrinkage in service and by increasing their density. A means of effecting these properties is now being studied and to date the results are promising.

The Mullite Group of Refractories

The possibilities resulting from the use of the sillimanite group of minerals (cyanite, andalusite, and sillimanite) for refractories has been a live subject in recent years. The physical and chemical properties of these materials are of a most promising nature. Their proper use in brick making has, however, required careful study and the full merit of the present products has not been established in many types of service. They appear to be of particular value in glass making furnaces. Their field will broaden in the future, filling in positions that cannot be satisfactorily met by other materials. The comparative cost of the raw materials will necessarily limit their field and place them in the class of specialties.

A noteworthy refractory material of this class is the cast mullite. This product, which is simply a casting of an electric furnace melt, is of considerable interest. Raw materials of the composition necessary to produce a true mullite are used for the melt and after being cast the shapes are annealed. The finished product has almost no pore spaces and is, therefore, of special interest in slag action. It has been found that the addition of low percentages of certain materials will substantially alter the properties of the finished casting, especially with regard to slag action. It is logical to expect that this principle will be applied to the manufacture of refractories of other compositions. Chrome, magnesite and spinel compositions should prove to be of value to the steel industry.

†Study being conducted by the Research Division of the Technical Department of the American Refractories Institute Fellowship, Mellon Institute of Industrial Research.

Chrome Refractories

In recent years chrome refractories have found wider use by reason of their improved properties. In order to manufacture such superior chrome brick, it is essential that the highest grade of chromite be employed. By reason of the quality of ore needed and the large tonnage consumed annually, the question of supply is important. Means of purifying or utilizing lower grades of ore should be studied. Chemical treatment or electric furnace refining are possibilities. The resistance of chromite to high iron slags makes it of interest for boiler settings in which a coal giving a high iron ash is fired. Their comparative weakness at these furnace temperatures and sensitivity to thermal shock precludes their use in this service at the present time. Future developments should extend their use to this service.

Other Refractories

In recent years a highly calcined kaolin refractory has been marketed and like other special materials it is becoming established in certain limited uses. This product, by reason of the purity of the clay used in manufacturing and the exceedingly high temperature to which it is fired, possesses some unusual properties for clay refractories.

In the case of magnesite, dolomite, silicon carbide and fused alumina refractories, no special comments will be made, since the findings of studies conducted on these materials are not of interest at this time.

Mention should be made of studies and the progress being made in the subject of testing refractories. Without adequate means of testing, progress in development and application of refractories is handicapped. Tests are the basis of specifications. The studies and experiences obtained in recent years have enabled technicians to develop noteworthy improvements in test methods and their use. Developments are leading to the simulation of actual service conditions and the lengthening of the time period of testing.

There never has been such interest in the field of refractories as is shown at the present time. Technicians of all classes are considering refractory problems from various angles. The chaotic condition of the past is gradually evolving into order through various channels. With constant study and co-operation between user and producer the whole field of refractories should make increasingly rapid progress in the future.

DISCUSSION

Mr. G. G. Coolidge, assistant general sales manager of the Harbison-Walker Refractories Company opened the discussion on Mr. Phelps' paper. He said:

Without question Mr. Phelps has covered the future progress in the field of refractories splendidly, and there is little that can be added. However there are a few points which he mentioned, which I would like to emphasize.

The producers of refractories earnestly hope that there will be closer co-operation in the future between producer and consumer than there has been in the past. This is bound to work to a mutual advantage. Most producers have a staff of research and sales engineers, who not only have a thorough knowledge of refractories but practical furnace design as well, and can offer helpful suggestions if the consumer will only give them an opportunity to discuss their problems with him.

As Mr. Phelps stated, to draw up specifications for refractories would be a very difficult task. In the first place it would involve a set of specifications covering refractories for blast furnaces and stoves, open hearths, glass tanks, by-product coke ovens, and in fact all types of furnace, due to the fact that operations vary considerably. If however, this could be accomplished, it would be particularly beneficial in the purchase of refractories, as it would first of all place each producer on an equal basis. In reply to an inquiry the manufacturer would be quoting on a refractory of the same chemical analysis, basic properties, etc.

There are several properties of refractories which are difficult to determine by laboratory tests, and tests which are used at the present time to determine certain properties are most unsatisfactory. Laboratory tests are often misleading and misinterpreted, and purchases made on laboratory tests alone have led many times to disastrous results in actual practice. Practical tests in furnace operation should be the guiding factor, at least for the present.

The quality and workmanship of all types of refractories have showed a marked improvement during the past few years, this being brought about by improved methods of molding, drying, burning, etc., and considerable capital will be invested in the future to continue along this line of improvement, which will mean the construction of continuous tunnel kilns, some of these kilns having been already constructed for the burning of clay brick, and in the near future Silica, Chrome and Magnesite brick will also be burned in the most modern type of continuous kilns.

Again let me urge closer co-operation between the producer and the consumer.

Mr. M. J. Terman, Refractories Division, The Babcock & Wilcox Company, Pittsburgh, Pa., stated that there is a real need for closer co-operation between the producer and the consumer to insure the proper specification and application of refractories to various types of service, in that many failures can be traced directly to misapplications. He also referred to interesting developments which have been made in kaolin refractories which are being used successfully in severe high temperature installations.

Mr. O. H. Davison of the United States Refractories Corporation in discussing Mr. Phelps' paper stated:

The United States Refractories Corporation is working very closely along the lines of the paper just read by Mr. Stuart M. Phelps. We are trying to improve our refractories at all times,—first, as to the selection of raw materials and preparing them for the service that they are to be put to; second, as to the process of making and inspecting; third, as to the careful burning and final inspection of the refractories material.

We are trying to co-operate as much as possible with the steel works engineers and operating men as to the use that our refractories are put to, and we aim to meet their requirements, to give the best results. A great deal of our refractories are machine made and we are improving upon our process of manufacture at all times.

As to our silica brick, we believe that we have a ganister rock that is second to none and I believe that we are the only manufacturers of silica brick who wash the rock. We are fortunate enough to have a large water supply and all of our rock is washed at

about 200-lb. pressure. This insures us of a very uniform material and washes away all of the foreign substances so that when our ganister rock is ground and prepared for our brick it is as uniform and free from foreign substances as possible.

Our standard shapes are all machine made and just recently we installed the very latest machine for making this brick which is practically an automatic operation, no hand handling. We also burn our brick at a higher temperature than others which means better refractories in every way.

As to regenerators, we are manufacturing and introducing an entirely new type of regenerator refractories material from which we expect to show some very good results within the near future, both as to longer life of the regenerators, sharper working furnaces and considerable savings in fuel.

Developments in 4-High Rolling Mills

By F. C. Biggert

Until somewhat over a year ago progress in the rolling of strip steel had practically come to a standstill. The existing mills had succeeded in hot rolling strip up to about 24 in. wide by 12 gauge and narrower widths as thin as 16 or 18 gauge. Some material may have been made thinner than 12 gauge in widths approaching 24 in., but I believe that the widths and thicknesses stated above represent the best commercial accomplishments of the time.

If wider material was to be rolled, it was evident that fundamental changes in mill construction must be made since increasing roll diameters, with the inevitable increase in neck friction which they imply, had about reached the practical limit.

The use of roller bearings was naturally considered, but no bearing could be designed which would support the required load and be small enough to assemble in the 2-high mills then in use.

We had built the 206-in. plate mill at Lukens Steel Company, and in it we used the 4-high mill, not so much to reduce power consumption as to limit the size of the chilled working rolls to dimensions within the facilities of chilled roll makers. This mill had been successful and had demonstrated the possibilities of the 4-high type as a means of producing wide and relatively thin material of exceptionally accurate gauge. That is to say, this plate mill had been found capable of rolling plates as thin as $\frac{3}{8}$ in. in widths up to 16 ft. and having a uniformity of gauge from edge to center quite as good as had previously been produced in ordinary widths. The life and behavior of the rolls were remarkably good. No spalling occurred and the medium carbon steel backing rolls maintained their shape well.

Some difficulty with fire cracking of the chilled rolls occurred due to the very large ingots used and the slow and heavy drafts in the early passes, but it was evident that with slabs such as would be used in strip mills, this would not be serious.

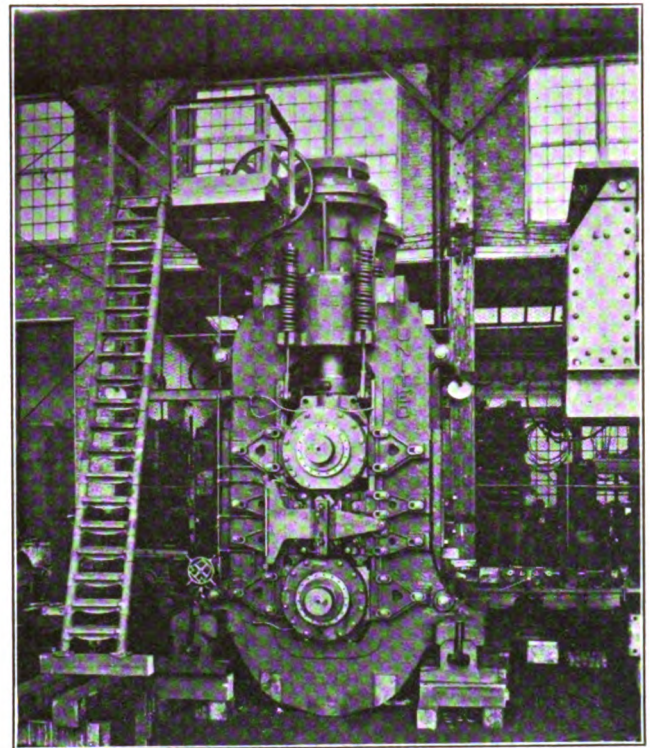
Considering the possibilities of wider strips in the light of this plate mill experience, we concluded that the same type of mill offered the means required. There were difficulties, however.

In rolling thin material, the power cost becomes a matter of importance, and while the 4-high mill is inherently more efficient than the older types, yet if run on ordinary bearings, the power per ton would still be rather high.

A large and expensive installation rolling thin material must deliver at high speed if tonnage, commensurate with the installation cost, is to be obtained, and with ordinary bearings, this would involve excessive heating.

On thin material a mill must maintain its setting much more accurately than in ordinary rolling. The wear of ordinary bearings, which, in thick rolling, is of small importance, becomes vitally important when the thickness approaches $\frac{1}{16}$ in.

All these difficulties could be overcome if roller bearings could be obtained capable of sustaining the loads involved.



Weirton 48-in. four-high hot strip mill showing roller bearing mountings.

Our engineers had developed the requirements thus far and had made some inquiries indicating that suitable bearings could be obtained, when we were called to the plant of Rome Brass & Copper Company, Rome, N. Y. to advise with that company as to means of improving their practice in producing sheet copper.

Having studied copper rolling practice, with which we had previously been entirely unfamiliar, we concluded that the 4-high roller bearing mill met the requirements completely.

The question of roller bearing design was discussed with Mr. W. Messenger of Philadelphia, one of the outstanding authorities in this field, and having determined sizes which, upon rather meager data, appeared to meet the requirements, a mill was built. It has proven satisfactory.

This mill had scarcely started and was still in a highly experimental state when Columbia Steel Company came into the market for a steel strip mill to roll 30 in. wide material down to 12 gauge; afterward changed to 36 in. wide by 12 gauge.

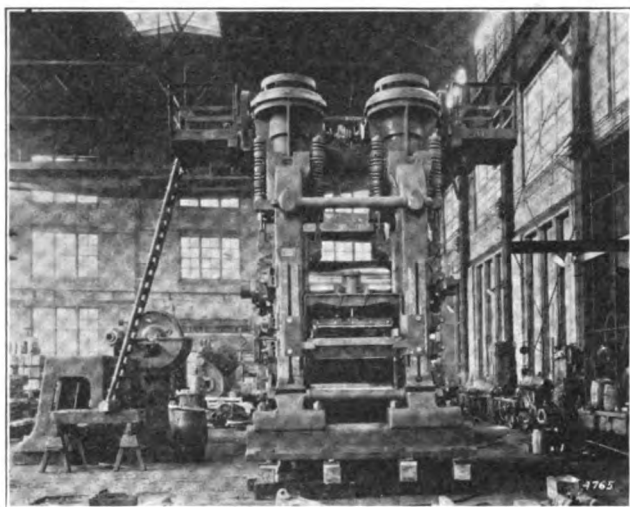
Here was a chance to try out the 4-high principle in a big way, but we were poorly prepared, having

still only imperfect data on which to base design. We decided to make a clean breast of the matter and see if Columbia would go along with us in a large scale experiment. The allurements were great and we convinced them that the experiment was worth making. They installed a universal roughing mill followed by four stands of 4-high hot mills arranged in tandem and five stands of similar cold mills. The E. W. Bliss Company supplied the cold mills.

Generally speaking, these mills have been successful, although bearing troubles have been encountered, to some extent, on the hot mills. This is primarily due to rolling 14 and 16 gauge material, in which case the steel is too cool when it is delivered to the finishing train. A universal mill is not fast enough for a strip mill rougher where the gauge to be finished is thinner than 12. Sheets as wide as 36 in. and down to 16 gauge are being produced on the mill, but changes will be required before this can be done satisfactorily. As the mill now stands, 12 gauge by 36 in. wide is its commercial limit.

Before the Columbia mill design was well started, Weirton Steel Company decided to install a tandem train of 9 hot mills and two 5-stand trains of cold mills to roll 48 in. wide. The experiment was getting too hot for us and we insisted that reliable data be obtained before proceeding with designs.

Pressure-measuring devices and also devices for measuring neck friction in ordinary strip mills were devised, built and applied, and from these devices we obtained remarkably consistent data upon which to base both bearing loads and motor powers.



Weirton 48-in. four-high hot strip mill, front view.

The Weirton hot mills have now been in operation for some three months, and so far neither bearing nor roll troubles have appeared. Widths up to 38 in. have been hot rolled to 16 gauge commercially, and 36 in. wide 17 gauge has been produced experimentally.

Other steel companies have also taken up this new type of mill. Lukens Steel Company has an 84 in. plate mill built among the first. Trumbull Steel Company has remodeled their 16 in. mill using five stands of 4-high in their finishing train and have thus increased its capacity from 18 in. to 30 in. widths. A further change in their roughing train will permit of rolling 36 in. wide. Youngstown Sheet & Tube Company has a single stand with 72 in. rolls. American Sheet & Tin Plate Company is installing six stands

which will be referred to later, and there are numerous others. Some 80 stands of 4-high roller bearing mills, hot and cold, have been contracted for within a period of less than two years, indicating the remarkable interest aroused by the development.

Just what will be the outcome of this development is difficult to say. There are the two distinct fields of hot and cold rolling to which the mill is eminently suited. In hot rolling, it is safe to say that 16 gauge is near the practical limit, although American Sheet & Tin Plate Company propose to go to 18 gauge by 28 in. wide, and will doubtless accomplish this.

Leaving the hot mill at 16 or 18 gauge, we have the choice of further reduction through cold strip mills or by packs on ordinary sheet or tin mills.

Both of these methods probably have their field of usefulness. For very light gauges, particularly tin plate, it may be that the hot pack will prove most economical. This is the method being tried out by American Sheet & Tin Plate Company, and it will surely reduce the cost as compared with present-day practice.

Down to 24 or 26 gauge, particularly for full finished and similar bright stock, there seems to be little doubt that the cold strip process is best. The operation of these cold mills is just beginning. At present we do not know either the minimum thickness or the maximum speed which may be commercially obtained, and until these factors are determined, it will be impossible to decide which process will survive.

Another factor of importance is the question of coating. We are not yet sure that the cold rolled material will take a satisfactory coat of either tin or spelter, but the probability is that by suitable preparatory processing, such coatings may be applied.

Where feasible, the cold strip process seems to have great advantages. Labor is much reduced; crop losses are almost negligible; pickle cost is from $\frac{1}{2}$ to $\frac{1}{4}$ of that for the pack process; frequently it will be advantageous to have the finished material in strip form rather than in sheets, and the remarkable accuracy of gauge should increase the demand for strips.

On the whole, we are disposed to believe that reduction by the cold process will ultimately prove to be the economical method of producing the large tonnage gauges, perhaps including tin plate.

The accuracy of rolling with these mills, is quite remarkable. It is not difficult to hot roll strips 250 ft. long 30 in. wide and $\frac{1}{16}$ in. thick with edge to center and end to end variation within .003 in. At Weirton this degree of accuracy has been exceeded in regular production. I have personally callipered coils 36 in. wide by .080 in. thick which showed only .002 in. edge to center variation. But this practice has been abandoned and about .004 in. fullness is being allowed on account of the difficulty of handling the more accurate coils in the cold mills. There is much less difficulty in cold rolling if the metal has an appreciable fullness at the center.

The practice in the hot mills is to start with a 3 in. thick slab regardless of the finished gauge, and with suitable edging equipment, an excellent edge is produced on the finished strip. The edges are somewhat rounded but very straight and smooth, so that even for the most exacting sheet requirements it will only be necessary to side trim about $\frac{1}{8}$ in. The length of strip is so great (200 to 400 ft. hot rolled and 300 to 1200 ft. after cold rolling) that end crop loss becomes almost entirely negligible.

A hot mill arranged like that at Weirton can easily produce 40 long tons per hour of 30 in. wide 16 gauge material. The theoretical discharge of this material at the usual finishing speed of 800 ft. per min. is 135 long tons per hour, so that placing average production at 40 tons, is doubtless conservative.

The possibilities of the cold mills are not so well established, but it is fairly well proven that a delivery speed of 200 ft. per min. can be maintained and that a reduction of 60 per cent in thickness can be obtained in a 4-stand train.

If then we start with 16 gauge 30 in. wide, we may reduce to about 24 gauge which, for 30 in. wide material delivering at only 150 ft. per min., amounts to a theoretical discharge of 10 tons per hour. Cold mills can be run on a very high production factor on account of the great length of entering piece, so it seems very safe to say that such a train should produce 8 tons per hr. of this material. This rate of production has been exceeded for short periods, and seems a very conservative estimate especially when we remember that there is good probability of attaining speeds higher than that assumed.

Power consumed per ton of product has not yet been well established, because all the mills now in operation are running intermittently and under adverse operating conditions, but such data as is available, indicates a power requirement about $\frac{1}{2}$ that used in ordinary strip mills for corresponding sizes. On 16 gauge material reduced from 3 in. slabs, we believe 80 kwh. per ton is a safe figure for hot rolling. Reducing 60 per cent cold from hot rolled material of 12 to 16 gauge, will require about 30 kwh. per ton.

The ordinary production of sheet mills is one short ton per hr. per mill. On 24 gauge sheets, we may allow one long ton per hr. as a monthly average per mill.

On this basis and that of the figures previously quoted for hot and cold strip mills, we may assume that one hot strip mill, such as those at Weirton or Trumbull, with enough cold mills to reduce its product from 16 gauge to 24 gauge, will be equivalent to 40 sheet mills.

But the sheet mills require sheet bar as their raw material, whereas the strip mill requires slabs which come direct from the blooming mill.

To make a true comparison, we must, therefore, place one hot strip mill with its complement of cold mills against 40 sheet mills and a very good sheet bar mill. The two plants will cost about equal amounts and should produce equal tonnages.

The problem of producing tin plate and sheets of corresponding thickness by the new methods, is particularly interesting and the American Sheet & Tin Plate Company is to be congratulated upon the steps they have taken in this direction.

Their scheme is to reduce to about 18 gauge in a 4-high strip mill, and match, double and finish on their existing tin plate mills. The entire roughing operation is thus transferred to the high production strip mill; the scrap loss should be reduced because of the very accurate dimensions of the pack at the doubling point, and finishing mills may be run at a higher rate because of the reduced roll heating.

Incidentally, they have burned no bridges since their hot strip mill will be equally well adapted to roughing for cold mills, should it be later found economical to finish cold.

So much for the historical and economic side of the development. From an engineering standpoint, the following may be of interest.

We have used roller bearings of the parallel roller type on the backing rolls, because we believed that this type was most suitable to the extreme loads to be carried. We do not know that this is true, but it is to be remembered that in starting this development, we were working in the dark. Speed, load and available space for assembly considered, these bearings carrying several times the load of any roller bearing previously used. Not only is the duty required greater than has been previously demanded of bearings of equal dimensions, but also the manufacture of such large sizes had been, by no means, standardized. On this account, we doubted the applicability of formulae of all roller bearing manufacturers, and were forced to rely largely upon our own analysis in determining both sizes and type of bearings.

The results of practice so far have been fairly satisfactory. On cold mills we have had no trouble, as the loads may be calculated with fair accuracy. Some of the earlier hot mills have given trouble which has been traced to two important sources. First, the excessive loads due to rolling cold steel, and second, the unavoidable stresses due to cobbles, broken rolls and similar accidents.

The increase in rolling pressure due to cold steel may easily double the load on the bearings. For instance, at Weirton, measurements taken at the beginning of a run when the first few slabs were not well heated, as compared with corresponding measurements a few minutes later, showed pressures in the ratio of 4 to $2\frac{1}{2}$ and the cold slabs were only about 100 to 200 deg. low in temperature.

There is no means for measuring the momentary pressures due to accidents, but it is obvious that they will increase the demands upon the bearings.

Neither of these occurrences causes immediate failure of bearings, but their repetition may ultimately result in failure, and good safety factors combined with good heating and good will practice, are necessary to obtain good bearing performance.

Working roll bearings used so far have been ordinary mill type bronze. The loads on these bearings are theoretically very small, and when the rolls are properly aligned, they are practically quite small. Since specially good alignment is necessary if good rolling is expected, regardless of bearings, and since the rolls once properly aligned, have little tendency to change their position, there is little need of more refined equipment.

Roller bearings have been suggested for the working rolls, but the small advantage, difficulty of assembly, cost and almost certainty of destruction every time a roll breaks, has prevented our recommending them.

Sizes of working rolls have been determined from the size of coupling necessary to transmit the required torque. We have based our designs upon elaborate full sized tests to destruction.

Backing rolls have been made of sufficient diameter to accommodate the required bearings, as this usually gives a roll of ample stiffness.

An interesting development in regard to working roll diameter, is that it has no appreciable effect upon the power consumption of the mills. This is, of course, contrary to all previous conceptions, but tests over a

wide range of diameters, have shown that for like reductions, the power per ton is almost exactly constant.

Of course, the rolling pressure increases with increasing roll diameter, and with ordinary bronze bearings, the larger necks absorb more power. This is the reason that in ordinary mills, the power per ton increases with increasing roll diameters. The friction coefficient of roller bearings is in the order of .0009, and consequently the power absorbed by necks is so small, that it has almost no effect upon the total power consumption.

This is important since it removes the principal argument for minimum diameter working roll, and permits the use of rolls large enough to stand severe accidental stresses.

Another prevalent idea that has been disproven is that the rolls of a mill tend to move out of the housings in the direction of the movement of the material.

The fact is that with equal diameters of top and bottom working roll, there is no tendency to move with the piece, but a back pull toward the entering side just sufficient to pull the material into the mill.

If the material is carried on roller tables moving at the same speed as the mill, this pull is zero and in no case can it be more than the friction due to the weight of the material.

This may be demonstrated by putting exactly equal rolls in any 2-high or 4-high mill and examining the lost motion of the chucks. They will be found usually to bear against the housing post on the entering side and may be displaced by a very slight pressure applied between chuck and housing.

This is not true when the rolls are of unequal diameter nor in the case of a 3-high plate mill where the middle roll is friction-driven from top or bottom rolls.

In the 4-high mills, it has been found advantageous to set the working rolls a small distance off center from the backing rolls. Usually this has been toward the delivery side, although they seem to work about equally well if offset toward the entry side.

We do not know any good reason for this displacement unless it be that it definitely establishes the direction in which the rolls will settle when the piece enters. If they are exactly on center, small unavoidable differences in diameter or other inaccuracies, may cause one end to settle backward and the other forward, whereas by giving a definite offset, they must settle uniformly. Whatever the reason, mill operators find it convenient to offset the rolls as much as $\frac{1}{4}$ in. and obtain more uniform results by so doing.

In the hot mills, after experimenting with rolls of various composition, it appears that fairly high carbon alloy steel backing rolls and chilled alloy iron working rolls will give the best results, although ordinary mild chilled working rolls have given good service where it has been possible to finish at proper temperature.

The cold mills have worked well with medium carbon steel backing rolls and hardened steel working rolls. Ordinary chilled backing rolls have also given good service, and on cold mills, it appears that any reasonably hard roll will serve for the backing rolls.

On both hot and cold mills, the experience available is not sufficient to warrant a definite statement as to the best combinations of working and backing rolls, but it is evident that rolls can be made which will give commercially acceptable service.

I might go on indefinitely discussing the possibilities and details of these mills, but enough has been said to show how very far-reaching may be the effect of their introduction into the art of producing wide flat metal products, and to give some idea of the problems involved in their design. This has been the object of this paper.

DISCUSSION

By Lloyd Jones

On November 7 the speaker received a letter from the American Society of Mechanical Engineers requesting a discussion of Mr. Biggert's paper on developments of four-high rolling mills. As there was no copy of the paper accompanied by the letter, the speaker was unable to work up a discussion on the paper as presented, and decided, therefore, to present a discussion on the general principle involved in backed up mills, of which the four-roll type is one of about five.

The application of mills with backed up rolls is not new, and has been practiced throughout the metal rolling industry continuously in various forms and shapes for over 60 years. There are approximately five types of backed up mills, as follows:

1—The three-roll type, of which the Lauth plate mill is the leading example, and is in general use throughout America. In this mill the two large rolls alternately become supporting rolls to the middle roll as the plate or sheet is run between the middle and the top roll, or between the middle and the bottom roll. Another common use for the three-roll backed up mill has been in the hot and cold strip industry, where its use has been common for over 20 years.

2—The four-roll backed up mill, where each working roll has one supporting roll.

3—The six-roll mill, commonly called the cluster mill, where each working roll has two supporting rolls.

4—The seven-roll, or what might be termed the three-high cluster mill, wherein there are three working rolls, the top and bottom of these rolls being each supported by two backing up rolls.

5—There is another type of four-roll backed up mill, of which there have been very few built. This is a modification of the three-roll mill. In this case, on account of the very small diameter of the work roll, it was supported on the bottom by two backing up rolls, the metal passing between the small roll and the large top roll. In this particular type of mill, rolls as small as 2 in. in diameter were successfully used in reducing metal.

Of these various types, the three-high is in most general use, with the four-roll and the cluster types following in order as named.

For the rolling of sheets and strips, the four-roll type and the cluster type are better adapted than the three-roll type, and will eventually supersede it altogether.

As to the relative merits of the two outstanding types of backed up mills, namely the four-roll and cluster types, their relative merits may be presented as follows:

Four-Roll Type—1—Shorter distance from the edge of the housing to the center of the mill.

2—Less number of rolls.

Cluster Type—1—No bearings for holding the work rolls in alignment are necessary.

2—The working roll cannot wear out of alignment, hence the cluster mill operator does not experience the difficulty which the four-roll operator experiences, due to the terrific end thrust of the working rolls when they become slightly crossed.

3—The working rolls can be more quickly changed, as there are no bearings to handle.

4—The working rolls automatically align themselves when placed in the mill by coming in contact with the two supporting rolls, eliminating the human element in lining up the mill.

5—The contact pressure between the work rolls and the supporting rolls is approximately 30 per cent less per inch of face on the cluster mill, as compared to the four-roll mill.

6—The working roll is supported in both directions of force, and hence smaller diameter rolls can be used to accomplish the same work.

7—With equal diameter of working roll, and with the ratio of backing up roll to the working roll approximately 2 to 1, which is the general ratio, the cluster mill has approximately 40 per cent greater capacity.

The E. W. Bliss Company, at their Salem Plant, of which the speaker is the manager, builds both types of mills, and has both types of mills in successful operation.

In regards to holding the rolls in alignment on the four-roll type, we have had our difficulties. The brasses on the necks become worn, or the mill is not set in correct alignment, and the rolls quickly develop an end thrust which makes the changing of the roll neck brasses necessary at frequent intervals. To overcome this tendency, the last mill which we shipped to the American Sheet & Tin Plate Company was equipped with roller bearings on the working rolls as well as on the supporting rolls. We were able to accomplish this because the mill was to be used for cold rolling purposes, and the working rolls were made of hardened tool steel, which allowed us to reduce the neck diameter sufficiently to install the bearings, and at the same time have sufficient strength to prevent the neck from twisting off.

It is a question in our minds whether this can be successfully done when the mill is used for hot rolling purposes, especially with rolls made of chilled iron. In this case we have to deal with a metal of low strength, and the torsional stresses would probably twist off the neck.

Another illustration having to deal with supporting the rolls in both directions, is the following experience: On the four-roll mill if a cobble takes place, the working rolls are apt to break and fly out of the mill. On the cluster type of mill, we had an accident where the metal being rolled escaped between the roll surface and the stripper, and passed around the working roll between the supporting rolls approximately six times before the mill was stopped. The only damage that occurred was that the working roll was marked and had to be taken out and redressed. No damage was done to the supporting rolls or to the roller bearings, and the six thicknesses of metal were reduced to the thickness being rolled, the six laminations being actually welded together cold. This was a remarkable example of the enormous pressure which roller bearings will stand.

We have been applying roller bearings to mills for the last three years on all types of mills,—four-high, cluster type, and also on the ordinary two-high mills. Our experience so far with roller bearings has been excellent, as we have had no failure or replacements to date.

In regards to the application of roller bearings to mills, this like the backed up roll principle, is so old that its beginning is almost lost in antiquity, as to the writer's knowledge, roller bearings on both two-high mills and backed up mills have been in actual use for probably 20 years in this country.

The principal difficulty which we find in the application of roller bearings to mills is the attitude taken by many of the roller bearing manufacturers, and as a consequence the general adoption of roller bearings to mills has been and is being seriously delayed, due to this attitude.

This consists principally in demanding a decrease in the neck diameter so as to favor the roller bearing to such an extent that on the chilled iron rolls the neck stresses are prohibitive. There is no advantage to be gained in operating a mill if you have a roller bearing that lasts forever, but have a very large percentage of roll breakages, with their consequent shutting down of operations. A far wiser and saner attitude would be to favor the roll neck diameter more, and subtract somewhat from the life of the roller bearing. I think that such roller bearing failures that have occurred can be traced more to improper mounting, and design of the bearings themselves, than to excessive loads.

The construction of the four-roll and cluster types of mills render themselves ideally to the application of roller bearings. This is one of the reasons why mills of these types are rapidly coming into favor. The power saved by the use of the small diameter rolls is not nearly as great as the power saved by the use of roller bearings. The roller bearing application, however, is spreading to two-high mills, and we have a number of them in operation at the present time, but with the exception of one or two cases the service has not yet been long enough to give us an indication as to their life.

With reference to the adjustment of rolls in the backed up mills, there is no difference in the principles involved, and the only departure has been the application of electric power to the screw downs in place of hand power. This, of course, is not new on plate mills, blooming mills, etc., but is new to the sheet and strip industry. In regards to the adjustment of the rolls as far as alignment is concerned, our practice is to so build the mill that the workman has nothing whatever to do with it.

In the cluster mill the working rolls align themselves. In the four-roll mill for cold rolling we put on roller bearings and take away all adjustment features. For hot rolling, where we have difficulty applying roller bearings to the working rolls, we believe that the best solution to this problem will be the adoption of the cluster type of mill in place of the four-roll mill. This will tend to solve several difficulties present in the four-roll mill which has up-to-date been generally used for hot rolling, namely the alignment of the working rolls, increasing the life of the supporting roll surface by from 30 per cent to 50 per cent, and decreasing roller bearing troubles now experienced, due to lighter operating loads and also reducing work roll breakage.

Another interesting feature about backed up mills is that on account of the small arc of contact with the metal being rolled, the total bending load on the mill is considerably less. This cuts down the deflection or spring in the mill, and in many cases obviates the necessity for crowning the rolls. The practice of shaping the surface of the roll to deliver a sheet or strip within commercial tolerances has been common practice ever since the speaker has had anything to do with the steel business.

When the first cluster mill was installed at Huntington in the early part of 1923, we assumed that it would be necessary to crown the working rolls and started that mill with the one roll straight and the other one crowned. The backing up rolls were all straight cylinders. We soon found that we did not need as much crowning, and this has been gradually reduced until the present practice uses very little crowning, indeed.

This question of shaping the rolls is becoming of less importance every day, and our practice now is to ship the mills from our shops with rolls ground perfectly straight. Whether crowning of the rolls is necessary or not seems to depend a good deal upon the product which is rolled in the mill. With the use of roller bearings, which eliminates the heat produced by neck friction, the swelling of the rolls at their ends due to increased temperature is being eliminated, and this in turn has a tendency to do away with the old practice of shaping the rolls.

It might be well at this time to touch slightly upon the historical phase. We find in about 1913 eight cluster mills in operation, and one four-roll mill. About 1916 the second four-high mill was installed at Lukens Steel Company. From then we have a gap of approximately seven years, until 1923, and since then we have had tremendous building of backed up mills.

During 1922, the International Nickel Company, at their plant at Huntington, W. Va., were making full finished nickel and monel metal sheets. In order to secure the desired surface, they found it necessary to grind, polish, and buff the sheet before sending it out to the trade. This was a slow and costly process.

In talking the matter over with their Dr. Thompson, and Mr. Weatherspoon, the speaker proposed cold rolling as a solution. We conducted some experiments and found that by reducing the thickness by cold working, we could secure a surface which would eliminate the grinding process. These experiments were conducted on the ordinary two-high mill with rolls approximately 18 in. wide.

To accomplish the same amount of reduction on the ordinary two-high cold rolling sheet mill, of which they had several in their plant, the rolls being 26 in. in diameter, we found it would be necessary to make from 40 to 60 passes. The speaker then proposed a mill of the backed up principle, and we were all convinced that was our only solution to the problem.

When it came to the choice of backed up mill, there were two types. The speaker was well acquainted with the four-roll type built for Lukens Steel Company, as all drawings for this mill, prior to being issued to the shops had his signature of approval on them. He was also familiar with the cluster type of mill which has been operating since 1913. In studying over the advantages of the two types of mills at that time, the preference fell to the cluster type, and this type was installed at Huntington.

We quickly found that we could accomplish in three to four passes on this mill what took 40 or more passes on the regular 26 in. mill. This mill was visited by practically every sheet and strip manufacturer in the country, and many of the prominent sheet manufacturers sent sheets to Huntington to be cold rolled.

This was really the starting of the modern strip method of rolling sheets, because it removed the limitations on the old cold rolling strip practice, and allowed them to adopt this practice to widths wider than they had been rolling, and further encroach upon the sheet trade.

The International Nickel Company is to be commended upon the courage displayed in investing approximately \$100,000 in an experiment which a great many sheet operators predicted was doomed to failure, and it remained for a producer of non-ferrous sheets to open the eyes of the great sheet and tin plate industry of America.

DISCUSSION

By R. J. Wean

The paper read by Mr. Biggert was very complete, and it is the thought of this discussion to deal with the commercial aspect of these 4-high and continuous mills. It is obvious that more thought and development has been put on the mechanical phase of these mills by Mr. Biggert and his company and others than has been given to the development of the market for the product made on this type of mill.

There is no question that steel in long lengths and in widths up to 42 in. can be rolled on hot mills of this kind, but when this product has been produced, it still remains in the form of hot strip steel and it is necessary to subject this to various finishing processes to impart the finished and physical properties required by the uses to which sheet steel is put. As these uses differ widely and are numerous, the sheet steel industry is an industry of specialties.

The great diversity of uses and the various modifications in treatment during the processes of manufacture, required to adapt sheets to these uses, make up a very long list of products. It is very unusual to have an extremely wide range of these various sheet grades made in one plant. Therefore, it cannot be expected that the operators of continuous 4-high mills can afford to finish this material into the wide ramifications of grades required to serve the sheet industry.

The installation and operation of continuous 4-high mills has affected the sheet steel market to such an extent that selling prices are much lower than they should be for either the sheet steel producer or the producer of wide strip steel. They have been competing in the same market, whereas it appears as though they might serve each other to supply the same market on a non-competitive basis.

Would it not be better for the producer of wide strip steel to furnish the sheet steel industry with material rolled down to 12, 14 or 16 ga. in the form of hot strip steel and permit the experienced sheet steel manufacturer to finish this material into the various grades required by the sheet consumers?

In this way there would be sufficient tonnage available for the wide strip steel operator to keep his mill in continuous operation and still make use of the existing sheet steel finishing capacity in this country.

(Continued on page 576)

Gas Producer Giving Efficient Service

Machine Which Has Been Gaining Popularity Abroad Introduced Here. Grate So Constructed as to Adapt the Producer to the Utilization of Low Grade Fuels

By R. M. CHATTERTON*

MORE economical use of fuel is an ever present problem in the steel and allied industries. It calls for the best efforts of engineers, which accounts for the interest manifest whenever a new piece of equipment is introduced giving promise of improved operating conditions or reducing the costs of manufacturing.

A striking example of engineering development resulting from the mutual exchange of experience and ideas by American and European Engineers is found in the Koller Gas Producers.

The necessity for conserving the limited fuel supplies of Central Europe since the ravages of and changes resulting from the World War, has resulted in many definite forward steps taken in spite of their limited resources.

Karl Koller, of Budapest, has been an outstanding engineer, devoting his time to the utilization of fuel, especially the low grade fuels to be found in those countries which formerly comprised the Austria-Hungarian Empire. His work is also recognized in Germany and many plants built over his designs are to be found there.

Because of the necessity for conserving raw materials in Central Europe, a great many existing gas producer plants have been rebuilt under his supervision or the supervision of those operating under his patents. Existing gas producers of many types have been fitted with grates of Koller design, thus greatly increasing their efficiency and reducing the cost of their operation.

The Manfred Weiss Steel & Sheet Metal Works of Budapest, has rebuilt thirteen Kerpely producers, fitting them with Koller grates. Four new Koller Producers are also now in operation in their works. The Glass Works at Sajoszentpeter has fitted two Kerpely producers with Koller grates and installed two new Koller machines. Likewise, the Glass works at Zagyvarpalva rebuilt two producers of the Grosse type, fitting them with Koller grates and has installed two new Koller producers.

In Czecho-Slovakia the Joseph Inwald Company rebuilt two Grosse producers for their works at Utekac and installed eight new Koller producers in their works at Zuckmantel. The Witkowitz Mining & Steel Industry at Witkowitz secured a license from Mr. Koller and built 32 producers of his design for operation in their own works. In Germany the City of Berlin has three Koller producer plants in their various public utility works. The first of four units is in Lichtenberg, five are installed in Tegel and four in Neu-Koln.

These are typical examples of installations made in Central Europe during the last few years. Some 400 Koller producers have been built and installed in Central Europe during the last four years.

Something over a year ago the work of Mr. Koller came to the attention of the engineers of The Gas Re-

search Company of Dayton, Ohio. Mr. Koller made a trip to America to become more familiar with American conditions and fuels. It was decided to introduce his producer into this country.

Design of Producer

Designs were carefully analyzed and changed where necessary to meet American conditions of use and manufacture. The resulting machine embodies the combined experience of European and American engineering practice. It is believed the final design of the Koller producer is the result of more complete tests on a greater variety of fuels than it has ever been possible to employ in the design of a single machine before this time.

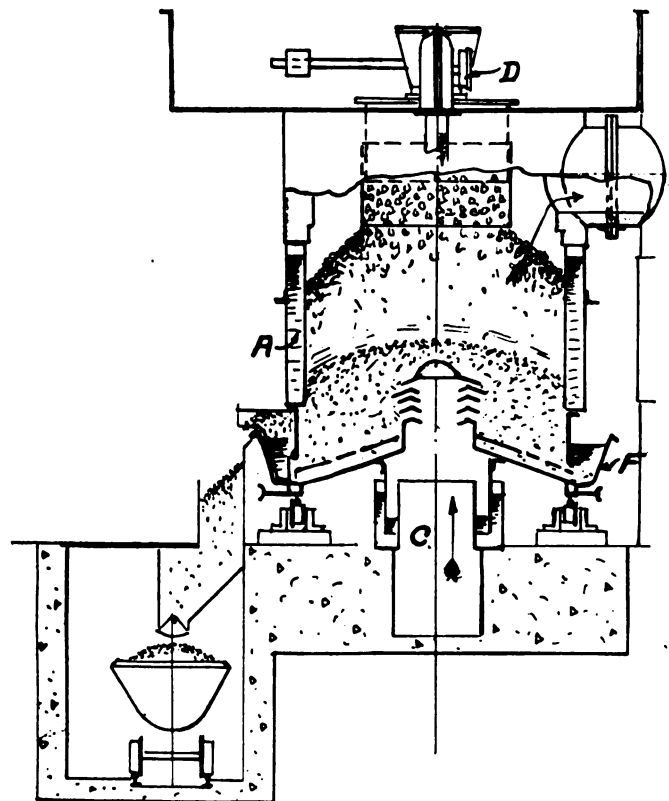


FIG. 1—Cross section of producer.

The Koller Gas Producer Generator is stationary. It is supported on steel columns and the jacket and top are water cooled. The revolving grate is supported upon three pairs of rollers which engage a steel track or ring made of heavy railroad rail. The grate is operated by a 3-hp. motor through a speed reducing gear and variable speed ratchet mechanism operating a worm and ring gear.

Spiral ribs are cast upon the upper surface of the grate which serve to shear the bottom from the ash column and force it under the seal ring into the ash pit pan. The ash is plowed over the edge of this pan. The spiral ribs serve not only to remove the

*The Gas Research Corporation.

ash from the generator, but also agitate the fuel bed from below, thus preventing the formation of chimneys in the fire at the point where they first start.

The fuel is charged to a central magazine which is vertically adjustable as to length so as to regulate the fuel bed depth for different kinds of fuel. Either a hand operated bell type charging hopper is furnished or a mechanical coal feed can be provided when desired.

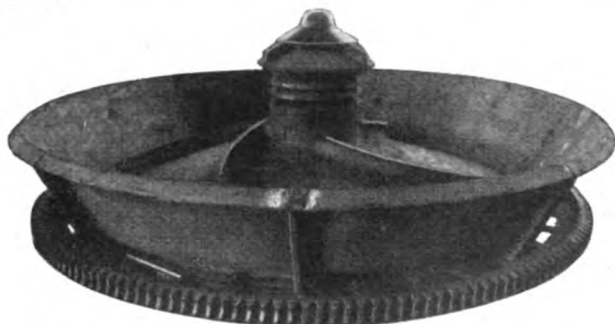


FIG. 2—Revolving grate for 10-ft. gas producer.

A motor or turbine driven blower furnishes the producer blast and is mounted on a saturator through which steam and air pass to the producer tuyere. An automatic regulator is provided for controlling the ratio of steam to air in the blast.

Automatic means are also provided for regulating the pressure of the gas in the top of the producer above the fuel bed.

Installations

The first Koller producers installed in America were purchased by the Eastern Rolling Mill Company of Baltimore, Md., and have been in operation for more than a year. They gasify buckwheat anthracite coal containing about 21 per cent ash. The results have been unusually good. The gas value is exceedingly uniform in quality and very high in heating value.

Since the Baltimore installation was made four other Koller producers have been put into operation and two Kerpely grates have been replaced by Koller grates. The second grate purchased was a repeat order after very satisfactory experience with the first one.

The latest plant to go into service is that of the E. I. DuPont De Nemours & Company at Carney's Point, N. J., which also operates on buckwheat anthracite and replaces a plant which formerly used bituminous gas coal. The engineering data obtained from the operation of the 10-in. Koller producer at the Du Pont plant is of interest to all fuel engineers.

Tests

These data and observations are taken from the plant log sheet during a 24 hour period September 29, 1927. This was not a test run, but is an example of daily operation.

The fuel used was Pennsylvania No. 1 buckwheat anthracite coal of the following analysis:

Moisture	4.86
Ash	11.27
Volatile	6.41
Fixed Carbon	82.62
Sulphur	.5
Btu. (dry basis)	13,430.00

Coal charged during 24 hour period 30,465 lbs.
Average coal charged per hour, 1,269 lbs.

Water used for cooling producer jacket and top 24,000 gals.

Average rise in temperature of jacket cooling water 100 deg. F.

Water used for scrubbing gas, 152,000 gals.

Average quantity of water used in scrubbing and cooling the gas 5 gals. per lb. of coal.

Average rise in temperature of scrubbing water 12 deg. F.

Steam used for saturating the producer blast at .3 of a lb. per lb. of coal 9,140 lb.

Average saturation temperature 122 deg. F.

Average temperature of gas leaving the producer 550 deg. F.

Average of 12 gas analyses made during the 24 hours, as follows:

CO ₂	2.6
O ₂	.0
CO	30.9
CH ₄	3.8
H ₂	16.9
N ₂	45.8
Combustible	51.6

Btu. value calculated by the constants used by U. S. Steel Corporation:

Gross	193.2 per cu. ft.
Net	180.9 per cu. ft.

Gas produced in 24 hours measured by Bailey meter 2,080,000 cu. ft.

Average output per hour 86,500 cu. ft.

Cubic feet of gas per lb. of coal gasified, 68.4.

The ash was analyzed with the following result:

Total water	26.3
Ash	70.7
Combustible	2.98
Ash (dry basis).....	95.95
Combustible (dry basis).....	4.05

This plant consists of a single unit and is equipped with a pyrometer for reading the gas offtake temperature, thermometers for indicating gas and water temperatures at various points in the system and the saturation temperature. Meters are installed for measuring the gas made and water used.

The gas cleaning and scrubbing equipment consists of a steel tower partly filled with spiral tile over which water is sprayed.

The Connersville Positive Gas Exhauster is driven by a steam engine.

The entire plant is operated by one man per shift, who handles the ash, charges the coal, takes hourly readings of all instruments and samples and analyzes the gas at two hour intervals.

The conditions which produced the results recorded above are not unusual as evidenced by the following figures secured from two other plants in operation in this country.

A plant consisting of two units operating on No. 1 buckwheat anthracite is producing gas of which the following is a typical analysis:

CO ₂	2.6
O	.4
CO	31.6
CH ₄	1.31
H ₂	17.0
N ₂	47.09
Btu. per cubic foot—Gross..	170.5
Net....	160.1

(Continued on page 581)

Complaints from the Consumer of Steel

The Causes for Many of the Troubles Arising Between the Purchaser and Manufacturer of Steel Are Pointed Out and Made Impressive by Experiences from Actual Practice

By J. R. MILLER

It is not often that anyone engaged in steel production cares to recount the complaints that come to him from users and fabricators of his product; and less often that he cares to give out in full measure the causes that underlie these difficulties, for in all such cases the spectator of claims and criticisms is before him.

If, through frankness and fairness, a really clear conception of the proper relationship between producer and user is ever reached much of the misunderstanding leading to claims as well as of the real trouble underlying the actual failure of the product will be eliminated. And it is surprising how much unpleasantness in sales relations, and how much inconvenience and additional cost is caused by such misunderstandings and which after all are reflected in price and profits. The proper relation between buyer and seller presupposes a frank and friendly relationship between the producing plant and the consuming shop, so far as quality and inspection matters are concerned. For great tonnages of standard material go out day after day for established uses and for thoroughly understood methods of fabrication, under simple inspection routine with almost no complaints at all; because everyone knows what is expected and nothing is expected that cannot be done.

So it is on the borderground of the poorly understood requirements of the unusual specification made up in ignorance of real conditions, or of the willful breach of trust and carelessness on the part of the producer himself, that troubles and claims and costly failures arise.

Sometimes it is a lack of knowledge (of his own requirement) on the part of the buyer in demanding or specifying a product which will not meet his need. As an illustration, one of the great railroads, with very well organized technical departments, formed the side sills of their freight cars from plates. These were pressed cold on a big hydraulic press into the proper channel form after the ends of the plates had been shaped by shearing. As the sills were full car length the plates were usually universal rolled. The railroad specifications called for certain physical properties just a little too high so that some of the steel proved too hard for the cold pressing operations. As many plates failed in the fabricating shops it resulted in a situation very costly to both mills and car shops, besides it took a long time to get the specifications changed to relieve the condition.

Often the buyer, not being conversant with steel making problems, does not make the proper allowances for unavoidable irregularities in steel mill operations. Instances of this are so numerous that it

would seem almost unnecessary to recount them; although this applies to all phases of operation, but particularly to steel making and ingot practice. With all the check analysis limits that are written into specifications one would think that a real knowledge of segregations and variations in analysis were his own

private monopoly. Mostly such specifications arise from simple intolerance and a brutal disregard of the producers' problems together with the desire to get a special service at the usual price. For, as is doubtless the case in many instances, if such limits are advantageous and desirable the sorting and checking of billet by billet can be arranged for in a business like way with the proper price agreement. Also, what would certain critical users think if they really knew all the facts about pipe, blow holes, soft centers, ingot structure, cracks and seams. A certain maker of tools had trouble with steel breaking in the first operation. He laid the trouble to badly piped steel. As a matter of fact his operation was unnecessarily severe and every piece of steel with a "soft" or weak center broke. Manufacturers of

pinions have used a great deal of common rolled round bar stock in the past, but heat treatment came into vogue and at the same time close inspection due to the severe service requirements. For a long time efforts were made to continue the use of cheap stock, but the zone of bubbles, that rolls out into hair line seams where the teeth are cut, could not be eliminated. A certain metallurgist investigating case hardening troubles learned that the steel in question showed peculiarities in its microscopic structure and that these queer places, which were due to variations in the ingot practice, could not be corrected in the mill that furnished the steel. Of course all the trouble was traced to these irregularities. Many users make petty complaints about small matters involving common and inherent steel defects which should be more allowed for and overlooked, but instead certain users drift from one source of supply to another and become more and more crabbed about it. It would be a very good thing if every metallurgist, passing on the steel supply of the user, became conversant with the steel mill problems.

Cases frequently arise in which the buyer refuses to acknowledge known facts but tries to gain some advantage by driving a sharp bargain based on technicalities. A certain large manufacturer of specialized equipment, who required occasional tonnages of a special section for his exclusive purposes, owned the rolls in the mill producing the steel. The section had never been very true owing to an original mistake in roll design but it had been used without complaint.

This is the first of a series of frank discussions dealing with the many disputes which unfortunately arise between the purchaser and the steel maker. The author writes from experience as he served for 18 years in the metallurgical and open hearth department of one of our largest steel corporations.

He also served for a considerable period as chief inspector at which time many of the instances here related came under his observation.

—Editor.

Finally the manufacturer was notified that the rolls were nearing the end of their life. He made a complaint about the rolling and asked for a redressing. The next rolling, about two car loads, was rejected on the ground that it did not conform to dimensions which, it was claimed, made its use impossible. He finally proposed to retain the bars at scrap price for scrap use. After careful review, the mill, through comparison of the rejected section with samples, kept from the previous accepted rollings, decided that the claim was unjust, and, at a considerable loss refused the offer, and at the same time ordered the material returned so that it could be remelted. The manufacturer later tried to obtain a reshipment of the rejected lot for its original purpose. This case demonstrates that it is never advisable to operate with a tacit understanding of the acceptability of an imperfect delivery.

A well known automobile manufacturer bought a large tonnage of forging bars. He designated the best specifications and agreed to pay extras. During times of increased demand he seldom made a claim although the mill, in order to make its deliveries on time, placed the business for rolling on mill units not favorable to the production of a proper product. The purchaser carried a large stock on hand and when demand slackened off became usually very critical in so much that at times he had to go over his stock bar by bar and make rejections which the mill had to accept in view of future business.

One of the most difficult and unsatisfactory conditions between the mill and the user is the control of the stock pile by the claim method. At the end of the year 1920 many shops had received deliveries of duplicated orders from several mills which had been placed to insure a supply. The claim method was used in many cases to reduce the excess in that unusual period.

A certain mill had a contract with a large user who was lax in his attention, to specification requirements. His work was of a varied nature and his various manufacturing processes required that some limitations be placed on the kind of steel used. The mill took advantage of this situation and was successful in disposing of stock billets and those of miscellaneous quality. This went along for quite a while, and, due to a friendly feeling, complaints were never pushed, but the day of reckoning came. The mill lost certain very attractive tonnages and the good feeling gave way to the necessities of the situation, specifications became even burdensome and what might have been an easy and profitable situation later resulted in a loss of business.

When the mill has "off grade" stock material, the "offall" of special grades with undesirable special sulphur and manganese content, the problem of its profitable disposal is very difficult. Then is a grade known to the trade as "soft steel" which includes such a wide range that there is little to justify calling it a grade. Into this grade all mill quality mistakes empties itself with a result that is better than would be expected. Now and then one encounters a brittle or a hard piece of steel and now and then there are a few rejections, but there comes a time when some user applies the material to a purpose where specification limits should have been set. The mill is of course, hard put to justify the application of the analysis of the steel and the situation is impossible until the cards are laid on the table and the right steel supplied. Here it is that the

inherent differences between open hearth and Bessemer steel generally shows up hence gradually the application of Bessemer loses ground on account of its cold shortness and its peculiarities in workability.

But carelessness is the bane of the mills. And it is hard indeed to conceive of all the troubles that may come about through some careless operation or accidental condition that makes good work difficult. And harder it is to locate and correct these faults and keep the shipments free from these errors and their effects. Human nature is frail they say, but just how frail no one knows better than he upon whom this particular burden falls. There is the heat of steel to which ferro manganese is added in the ladle and which now and then shows two or three ingots at the end of the teeming showing up to maybe 3 per cent manganese, and this will go through the mills and be rolled into bars and perhaps no one will detect it. There is the ingot that strayed away from its fellows and got into the wrong company, or the billet that stepped over the line. And when these get to the customer there is apt to be trouble. There are also those stock piles of billets painted and repainted and dug over and all mixed up until finally they are put in the order "on the night turn." Maybe you will say—oh, this mill or that mill—they don't do such things. Some of these failures are due to gross carelessness but some however are due to conditions of operation imposed by the design and arrangement of the equipment. Some of them are inherent in the "atmosphere," of this place—that is the sentiment that comes down through the line from the top. It is not too much to say that for the most part they can be eliminated at not great cost or sacrifice but with thought based on fairness and a broad conception of fairness. Of what use to blame some workman or to impose on some good buying friend and how much profit is made by it anyway?

When the mill understands the users problems and the user understands broadly the mill problems in connection with some delivery, that delivery is generally satisfactory. Cards on the table and a general good understanding is all that will solve the quality problem.

Consumer and manufacturer should have an explicit understanding of the conditions to be faced by both and each should conform to the agreement. Should some misunderstanding arise a frank open discussion will usually clear up the difficulty.

Iron and Steel Division of A.S.M.E. Meets

(Continued from page 572)

This same application can be made to the manufacturer of tin plate, as witnessed by the installation of one of these mills for the production of tin mill breakdowns alone. The potential market for this material in the tin plate industry can well be realized when one considers that the total production of tin plate in the United States in 1926 was about 40,000,000 base boxes.

Surely the development of this market is worth considerable thought. The co-operation of the wide strip producer and the sheet steel producer would not only work out to the economic advantage of both of these companies, but to the entire steel industry as well; and most certainly to the stockholders who have invested their money in these companies.

The Effect on the Furnace of Ash in Coke*

Data Is Taken from Practice to Show the Results in Furnace Operation When the Ash Is a Variable Quantity. More Ideal Conditions Obtain Where Percentage of Ash Is Constant

By C. S. GILL (Consett)

CONSIDERABLE attention has been given recently to the coke for blast-furnace use, and valuable investigations have been and are taking place in England and in America, in order to define those attributes of blast-furnace coke which give the most satisfactory results in practice. The author feels, however, that so far this question, which is, perhaps, the vital governing factor in successful blast-furnace operation, has been very largely left to scientific observers, and it is difficult to obtain actual figures of the results produced in large-scale practical operation. As he has fortunately been in a position to make some practical tests, this paper is written to make known the information thus gained, and if possible to encourage others also to publish figures showing the effect of variation in the quality of coke supplied to the furnaces.

It has frequently been stated that the blast-furnace manager does not really know what sort of coke he requires, and, if this means an exact definition of the coke for all blast furnaces under all conditions, this may be true. There would appear to be little question that the coke which gives satisfactory results under certain conditions of furnace lines and ore to be smelted might, under other conditions, give less satisfactory results, and probably this accounts for the fact that there is frequently a discrepancy between the ideal cokes as specified by different furnace managers. There is no doubt, however, that they all agree that the coke they require is one which, with their individual conditions of ore, etc., shall give quick driving of the furnace together with low coke consumption.

While the above is true, there are some characteristics of coke upon which all blast-furnace managers are unanimous; as has been frequently pointed out, a good blast-furnace coke should be low in sulphur, ash, and moisture, of regular analysis, free from fines or breeze, and of such physical strength as to resist the abrasive action of the furnace itself. There is another characteristic which is more difficult to define, sometimes spoken of as "reactivity" or "combustibility," and which for practical purposes means "that characteristic of coke which promotes quick, regular, and economical driving."

As to which attribute of coke is the most important, it is not always easy to say. High ash or sulphur are either of them definite evils, but if they are regularly and consistently high, it is possible to so burden the furnace that the evil results are confined to increased expense in the production of the pig iron. On the other hand, a fluctuating ash is an unmitigated evil, as it is impossible to so arrange the burden that the furnace shall give reasonably consistent results if the ash in the coke is varying from hour to hour even to the extent of $1\frac{1}{2}$ or 2 per cent; and probably many practical operators would agree that they prefer a coke consistently carrying 12 per cent of ash

rather than one in which the ash fluctuates from 9 per cent to 14 per cent.

In presenting figures obtained in practice, one is always faced with the difficulty of making the results truly comparable, owing to the multitude of varying factors which enter into any large-scale operation; if these variables are ignored, entirely erroneous conclusions may be drawn. The following results are, however, comparative in the sense that the ore mixtures, type of iron produced, stove temperatures, etc., were maintained as nearly constant as possible.

Effect of Fluctuating Ash

It has been stated above that a fluctuating ash is an unmitigated evil, and as an illustration of this the following is cited:

Early in 1924 very serious trouble was experienced owing to the fluctuations in the quality of the iron from cast to cast. Repeatedly the quality would change from No. 1 grade to practically white iron within a few hours, and then back again to good iron.

The average ash content of the coke did not fluctuate to an abnormal degree from day to day, but after the strictest supervision of the weighing of materials and the charging of the furnaces had revealed nothing wrong, the conclusion became inevitable that the root of the trouble must lie in the coke.

Arrangements were made for hourly samples of the coke to be taken as it was being charged to the furnace over a period of 24 hours. These samples, weighing from 7 to 8 cwt. each, were taken from all the slides from which the coke was being filled, and so were representative of what the furnace was receiving.

From the dimensions of the furnace and speed of driving it was not difficult to calculate with tolerable accuracy how long it took the coke to reach the hearth of the furnace and, from this, to identify the cast or iron corresponding to the coke charged at any given time. The results are shown in Table I, in which the samples of coke have been apportioned to suit the length of time which elapsed between the different casts—roughly, $5\frac{1}{2}$ hours.

The table is self-explanatory, but in view of the great difference in the quality of the iron corresponding to what might be considered a comparatively small variation in the percentage of ash, it should be remembered that each increase in ash not only reduces the percentage of total carbon in the coke, but increases the weight of slag formed, which in its turn requires an increased amount of carbon to raise it to its melting point and superheat it to the temperature of the furnace, so reducing considerably the carbon available for the other necessary chemical and thermal reactions of the furnace operation.

Fig. 1 shows the hourly ash figures, and the corresponding sequence of sulphur results in the iron produced is appended, and serves to illustrate how sensitive the furnace is to quite small variations in available carbon.

*Paper delivered at meeting of British Iron and Steel Institute, Glasgow.

TABLE I

Time sample taken Hour	Ash as Received %	Average %	Sulphur in Pig Iron Top of cast %	Bottom of cast %
11 P. M.	14.56	14.53	0.194	0.252
12 midnight	14.13			
1 A. M.	12.03			
2 A. M.	14.82			
3 A. M.	15.84			
4 A. M.	15.81			
5 A. M.	15.26	13.06	0.040	0.091
6 A. M.	12.56			
7 A. M.	13.29			
8 A. M.	13.65			
9 A. M.	10.55			
10 A. M.	9.57	10.74	0.030	0.025
11 A. M.	10.18			
12 noon	12.34			
1 P. M.	11.40			
2 P. M.	10.35			
3 P. M.	10.59			
4 P. M.	10.81	13.28	0.102	0.117
5 P. M.	14.63			
6 P. M.	14.02			
7 P. M.	13.51			
8 P. M.	13.43			
9 P. M.	13.08	14.33	0.065	0.222
10 P. M.	15.58			

As the casts were run on the pig-beds commencing at the bottom and finishing at the top, the sulphur results in the graph are shown in the order in which the iron was made in the furnace.

Effect of Consistent Ash

The following illustration is given as showing the effect of changing the ash in the coke supplied to the whole of the blast-furnace plant. It has, perhaps, special interest for the following reasons:

(a) The results are averaged over five weeks in each case. Period I gives the figures for five weeks immediately prior to the change, and Period II, the corresponding figures for the five weeks immediately following the change, omitting altogether the week during which the change-over was effected.

(b) The figures are actual averages of the results at a number of furnaces, and not of one selected furnace.

(c) Both coke were similar in physical characteristics, being made in the same ovens, and under identical conditions.

	Period I	Period II
Average ash in the coke	12.15 per cent	9.76 per cent
Average weekly make of pig iron.	3311 tons	3819 tons
Tonnage of No. 3 grade	210 tons	134 tons
Percentage of No. 3 grade	6.34 per cent	3.51 per cent
Average pressure of blast	5¾ lb. per sq. in.	4¾ lb. per sq. in.
Percentage increase in make ...		15.4 per cent
Reduction in coke consumption		1.01 cwt. per ton pig

The above figures speak for themselves, but they do not give a full idea of the improvement which took place in the practical operation at the furnaces. During both periods the endeavor was made to produce iron high in silicon for sale purposes, but during Period I the furnaces were "stiff" and the results unsatisfactory, while during Period II the furnaces worked freely and gave consistently good results.

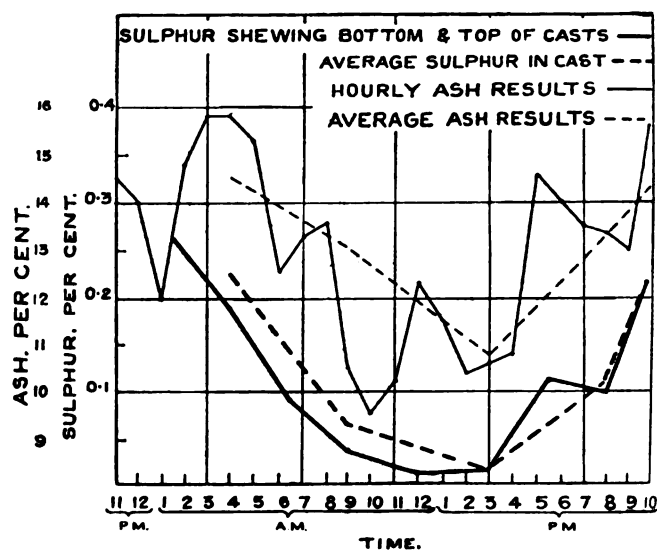


FIG. 1.

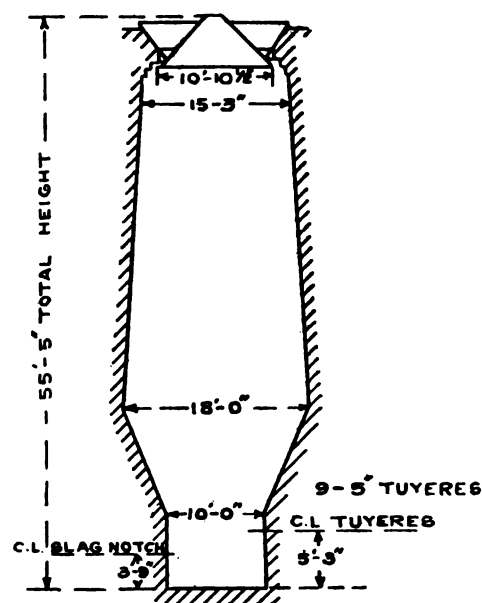


FIG. 2.

FIG. 1—Curves showing hourly ash figures.

FIG. 2—Sketch giving dimensions of furnace.

On another occasion a similar change-over was made on one furnace only from a coke containing 12.5 per cent of ash to one averaging 8.75 per cent of ash, and the test was kept up for nearly five weeks, during which complete records of all analyses, temperatures, pressures, etc., were carefully gathered, but for the purpose of this paper it is only necessary to give the data shown in Table II.

The results (Table II) were obtained in small furnaces, the most recent of which was built in 1880. Fig. 2 is a dimensioned sketch, which is representative of all, though there are minor differences.

TABLE II

	Before Change-over	After Change-over
Percentage ash in coke..	12.5 per cent	8.75 per cent
Average weekly make of pig iron	950 tons	1190 tons
Percentage increase of make		25.25 per cent
Reduction in coke con- sumption		1.76 cwt. per ton pig

An examination of the economies effected in the two tests given proves interesting. Thus in the case where all the furnaces were changed over from coke with 12.15 per cent of ash to coke with 9.76 per cent of ash, an improvement in coke consumption of 1.01 cwt. per ton of pig was the result.

Saving in coke, 1.01 cwt.

Reduction in ash, 2.39 per cent

= 0.42 cwt. of coke saved per 1 per cent
reduction in ash.

At the same time an increased make of 15.4 per cent resulted.

Increase in make, 15.4 per cent

Reduction in ash, 2.39 per cent

= 6.4 per cent increase in make per 1 per cent
reduction in ash.

Working out the results obtained in the second case where one furnace was changed from coke with 12.5 per cent of ash to coke with 8.75 per cent of ash, the figures obtained are:

0.47 cwt. of coke saved and 6.7 per cent increase in make
—per 1 per cent reduction in ash.

These figures are remarkably consistent, in view of the fact that the two tests were carried out at quite different times and had no immediate relation to each other; they provide a basis upon which the whole question of the provision of low-ash coke for blast furnace use may be worked out from a financial standpoint.

Thus, in a case where two cokes were available, containing 12 per cent and 9 per cent of ash respectively, the reduction in coke consumption by the use of the latter would be $0.42 \times 3 = 1.26$ cwt. per ton of pig. This, based on coke at 20s. per ton at the furnaces, is equivalent to a direct saving of 1s. 3d. per ton of pig made, and it is a simple matter, knowing the coke necessary to make 1 ton of pig iron, to work out what extra price could be paid for the lower-ash coke as compared with the other, while still maintaining a margin in costs.

The indirect saving due to increased output, more regular product, etc., can only be estimated with a knowledge of local conditions at each plant, but the gain is material.

In conclusion, the author wishes to express his thanks to E. J. George, Esq., for permission to publish the figures given in this paper.

Hoover Speaks to American Institute of Steel Construction

Secretary of Commerce Herbert Hoover opened the fifth annual convention of the American Institute of Steel Construction at the Hotel Carolina with a

speech which he actually made in his office in Washington. The speech was recorded by the Victor Talking Machine Company by apparatus specially installed in the Commerce Building, thereby enabling the Secretary's words to be presented as directly as if he were present in Pinehurst instead of being detained in Washington by pressure of business.

To the President and Members of the American Institute of Steel Construction and Guests:

I am glad to greet you at the opening of your annual convention. While I regret that I cannot be with you in person, it is indeed a pleasure to speak to you as directly as if I were present. In any event this new method of approach offers many advantages and some possibilities, not the least of which is that there is a known terminal to the speaker's remarks and a consequent great elimination of waste in your time. Moreover the response of an audience composed of a single microphone raises inspiration to oratorical efforts in about the same degree as an address directed to the bathroom door knob. So that if this method develops into general use, and would thus eliminate superfluous oratory in public speakers, I am all for it.

But, I am glad to congratulate you on the progress of your Institute since its organization in 1921. Each year has brought a closer approach to the achievement of your objectives and the fulfillment of the purposes for which the Institute was founded. There has come about through your good offices a better understanding of the mutual problems of the steel fabricators and steel producers. Your effort to advance your industry through establishing standard codes of practice and ethics, and to take advantage of scientific and engineering research is in line with the advancing vision of our great industries in their broader concept of service to the consumer, and thus to the public.

This enlargement of vision, and this evident desire to be of service to the ultimate consumer are outstanding developments of the post-war era of American business. It makes for greater stability in business and a greater public understanding of the purpose of business as a part of our whole co-operative nation.

I was glad indeed to see your interest in welding as a newer method of assembling steel structure. Your welding research program may yield some very remarkable results and might even revolutionize steel construction methods. If the fellow who is laying a street car track outside this window with the assistance of a pneumatic hammer only knew it, I would be grateful right now.

In any event, your effort is a real practical step based on sound scientific research. Its success would promise economies in construction costs surpassing those already achieved by your work in simplifying and standardizing design. You have already accomplished much in this latter direction, and the further work which your association is doing in co-operation with the Bureau of Standards in the development of standard steel specifications is another sound step.

Back Issues Wanted

The publishers of Blast Furnace and Steel Plant desire to obtain copies of this magazine of the March and May, 1927, issues. Will persons having such copies please advise Steel Publications Inc., 108 Smithfield Street, Pittsburgh, Pa.

Cooling Coke by the Dry Quench Process

By This Process the Sensible Heat in the Coke Is Made Available
for the Generation of Steam—Equipment Required
and Economies Obtained Are Set Forth

By CHARLES LONGENECKER

IN the days of the bee-hive oven any attempt to effect economies received very meagre consideration. Our industries in that period were all comparatively wasteful, but with the introduction of the by-product oven the coking of coal underwent a distinct transition. In fact the adoption of the by-product method, although gradual at first, was assured for the reason that by this process economies, which formerly had been flouted, were then made possible. Some years were required to convert the skeptical to the change, but once there was a unanimity of opinion refinements in methods, accompanied by further savings, were realized. This progressive spirit has characterized the coking industry since the transition period mentioned in consequence of which there has been a continual striving toward economy of operation.

Efforts to effect improvements have centered largely in increasing the yield of by-products, the quality of the coke, the manner of handling the coal and the coke, etc., but until the present little has been accomplished in utilizing the sensible heat in the coke after it is pushed from the ovens. A process has now been devised by which this heat can be recovered and the efficiency of the system, as a whole, raised.

Many engineers have endeavored to make effective some means of reclaiming the heat usually lost and at the same time cool the coke, but such endeavors have met with but little success until the Sulzer Freres of Winterthur, Switzerland, conceived the system here described.

Theory of Dry Quenching

The theory of the system is exceedingly simple. Coke is taken direct from the discharge side of the ovens and is carried to what is termed the "Dry Quencher," a part of which is a large steel container having a capacity of approximately 40 tons of coke. Into this container the coke at a temperature of about 800 deg. F. is dumped from a skip hoist so located that it can serve two containers. The container charging opening is then sealed and a current of inert gases is forced up through the body of coke to a discharge opening at the top. From here the gases, which have absorbed heat in passing through the coke, flow into two horizontal fire tube boilers, placed one above the other and while in the boilers impart sufficient heat to create steam. By this simple method the temperature of the coke is reduced and its heat is utilized in an efficient manner. The coke remains in the container until its temperature has been sufficiently reduced when it is discharged through the bottom by means of a feeding device. From the foregoing brief description of the principle it is obvious that the inert gases are subject to alternate heating and cooling as they complete the cycle from and to the fan, but otherwise they undergo very little change. A cross sectional view of one unit (see Fig. 1) clearly illustrates the manner in which the cycle of air flow is completed. The coke suffers no change other than a reduction in

temperature. If the coke enters at a temperature as high as 2100 deg. F., which is desirable, it will naturally require a longer length of time to cool it but whatever the temperature may be the time of discharge is automatically regulated. It is necessary to maintain practically a full body—40 tons—of coke in the container at all times accordingly, when a car load arrives for charging a portion of that already cooled

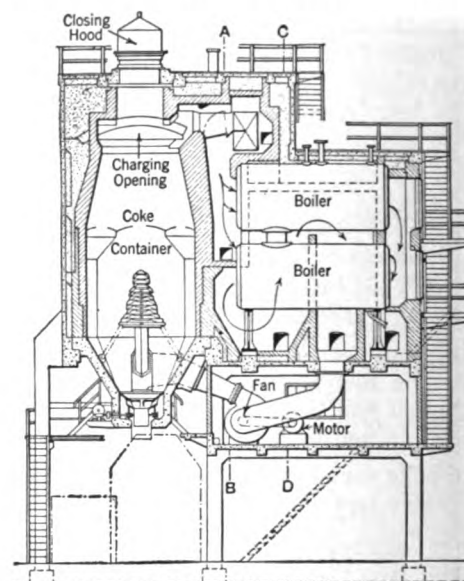


FIG. 1—Diagrammatic view of a Sulzer dry quenching coke plant.

must be removed. In order to judge the amount in the container and thus determine the amount to be removed a device has been installed by means of which the top level of the coke can be discerned whenever desired. The third element—steam—which is necessary for carrying out the process is handled as in any boiler installation and consequently there is no need to comment on the part it plays.

Position of Machinery

To make the system operative the machinery is arranged as shown in Fig. 2. The skip hoist, which receives the coke from a coke car, is placed between two units and from its top a chute is so placed that it can, in turn, deposit coke into either of the two units. The operation of this chute is automatic in that by appropriate mechanism the chute can be set to receive coke from the hoist and to discharge it into either of the containers. Automatic means also control the closing of the charging opening into the container.

Besides the container and boilers each unit is equipped with a fan whose function is to draw the gases from the boilers, and force them through the container. This piece of mechanism is the only one in the unit that moves hence there is very little wear to the equipment.

The fans for causing a flow of gases are driven by a 50 hp. variable speed motor hence any speed adjustment can be secured.

As the coke, when placed in the container, is at a temperature of at least 1800 deg. F. it is apparent that any admission of air would cause the coke to burn, consequently only an inert gas can be employed as the medium of heat transfer. This fact makes imperative the necessity for absolutely tight walls throughout the whole system. A single opening would only allow an infiltration of air with a consequent waste of coke.

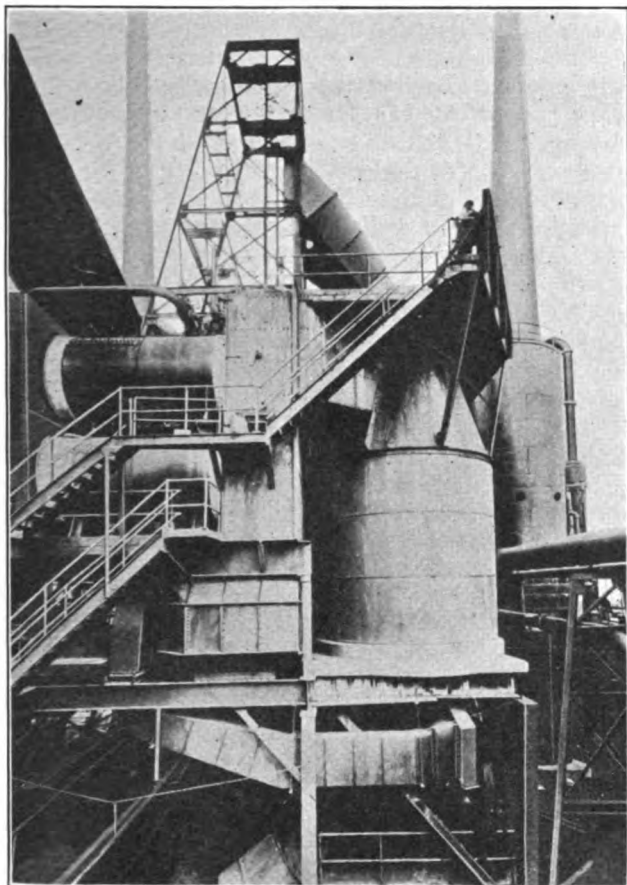


FIG. 2—Exterior view of quencher.

In Fig. 2 it will be seen that the upper and lower boiler are connected at the front thus permitting a certain quantity of gas to be by-passed. The object of this split flow of the hot gas is to obtain a more even heating of the two boilers.

Each boiler is made up of tubes $2\frac{1}{2}$ in. in diameter and 18 ft. long so disposed that the upper boiler contains 282 tubes and the lower 320 tubes. These boilers have sufficient capacity to create steam from the heat contained in 2125 tons of coke as a daily charge. Accordingly two units can accommodate 425 tons of coke. With the entering coke at a temperature of 2100 deg. F., 370 lb. of steam, at 150 lb. pressure can be obtained per 1000 lb. of coke cooled.

In operation the following results have been obtained in an American plant:

Normal operating temperatures, etc.

Inlet boiler—1200 deg. F., immediately after charge;
800 deg. F., just prior to charging.
Outlet boiler—300 deg. F. to 350 deg. F.
Pressure drop across fan— $4\frac{1}{2}$ in. to 5 in., H_2O .
Volume of circulating gases—23,0990 cu. ft. minute.

Operating results:

Average power consumed per day, fans..	858.2 kwh.
Average power consumed per day, hoist..	82.8 kwh.
Average temperature of feed water....	119.3 deg. F.
Average steam pressure.....	139.2 lb. sq. in.
Average coke charged per day, 1,000 lb.....	728.4
Average temperature of hot coke inlet to quencher	1,775 deg. F.
Average ash content of coke.....	10.5 per cent
Average breeze content.....	5.5 per cent
Actual steam production under above conditions per 1,000 lb. coke cooled, determined by water meter	396.8 lb.
Coal—Straight Pittsburgh $\frac{3}{4}$ screened high volatile coal of average analysis—	
Volatile	34.0
Fixed carbon	58.0
Ash	7.0
Sulphur	1.0

As compared with the common practice of wet quenching the advantages of the process may be listed as:

- 1—Recovery of a large portion of the sensible heat in the coke which is entirely lost in wet quenching.
- 2—Elimination of water, with the expenses attendant upon its use and with the difficulties experienced from wet coke and heavy vapors.
- 3—Coke is better suited for use in gas producers and blast furnaces as the cells of the pieces contain no moisture.
- 4—Pieces are stronger than the wet quenched product.

Another Progressive Step

With the intention of further improving the service to subscribers Steel Publications Inc. will hereafter mail Blast Furnace and Steel Plant in an envelope instead of in a wrapper as heretofore. This innovation brings the magazine to subscribers perfectly flat and obviates the necessity of cutting the wrapper.

Gas Producer Giving Efficient Service

(Continued from page 574)

The fuel used in this plant contains 21 per cent ash. In another plant operating on Kentucky bituminous coal the following results were secured. This analysis is an average of several taken during one day's run:

CO_2	4.5
O_2	.4
CO	26.05
CH_4	6.37
H_2	14.22
Combustible	46.6
Btu. per cubic foot—Gross..	204.8
Net....	173.3

Average heating value during 24 hour period by recording gas calorimeter, 182.

Most of the data set forth in this article are taken from producers operating on fine anthracite. Buckwheat anthracite and small coke are the cheapest fuels obtainable for gas making in many localities. It has been recognized that the making of a gas of good quality from these fuels would be a long step toward the ultimate solution of the fuel problem for certain parts of our country. Having this in mind this information is submitted with the belief that it will be of interest to many fuel engineers, and in the hope that it will be of assistance to them in solving their ever present fuel problems.

Open Hearth Executives Discuss Problems

Steel Makers Consider Many Features of Plant Practice at Semi-Annual Meeting. Pit Practice, Open or Rimming Steel Manufacture, Air Preheaters Leading Topics

By C. W. VEACH*

THE sixth semi-annual meeting of the Open-hearth Committee of the Mining and Metallurgical Engineers Society was held in Hotel Statler, Detroit, on November 2, 3, and 4.

A large representation of Open-hearth Executives had arrived by 9.30 Wednesday morning when L. F. Reinartz, Chairman of the Committee, called the assembly to order.

The Chairman introduced Mr. John V. W. Reynnders, past president of the Society, who made the address of welcome. The idea of a Committee of Open-hearth Superintendents originated with Mr. Reynnders, therefore he is much interested in its progress. In his address besides pointing out the importance of discussing the questions on the program freely and frankly, he also alluded to the value to open-hearth executives of informing themselves about problems other than those directly connected with their work.

He said it was especially important for the open-hearth executives to know something of the problems with which the blast furnace operator must contend, and of the problems assumed by those responsible for the product after it passes from the open-hearth.

In short, he emphasized that co-operation is essential and that a certain amount of tolerance is due to those furnishing materials, as well as to those into whose hands the product passes on its way to completion.

Meeting Well Attended

Interest in the transaction of the open-hearth committee is interesting with each meeting, as the large attendance at Detroit shows. There was a total of 87 members registered. It is noticeable that the discussions are becoming more and more spirited, and the questions are discussed frankly and in detail. Nor is the exchange of experiences confined to the sessions alone, but groups of men discuss their problems at other times. And fully as much information passes from one to another in this way as is exchanged in the assembly room. So it is impossible for any one to attend these meetings and not learn something of tremendous value both to himself and the firm employing him.

Under the able leadership of the chairman none of the discussions lagged. And while some were manifestly more fluent speakers than others most every one in attendance took part in the discussions, and gave their experiences in a clear and concise manner.

Scope of the Discussions

While some 25 questions were listed in numerical order to form the program, some of them suggested related subjects.

It should prove of interest to steel manufacturers to know what questions those who attended the meeting at Detroit considered, hence, below is a list of the questions as they appeared on the program.

*Open hearth superintendent, Bettendorf, Iowa.

November 2—Meeting 9.30 A. M.

- (a) Registration.
- (b) Distribution and explanation of Open-hearth Construction Questionnaire.
- (c) Discussion—Use of preheaters for heating air before going into the regenerators of an Open-Hearth furnace as compared to installation of waste heat boilers.

November 2—Meeting 2.00 P. M.

- (1) Pit Practice.
- (2) Open or Rimming Steel Manufacture.
 - (a) Top Pour;
 - (b) Bottom Pour;
 - (c) Effect of high residual manganese;
 - (d) Deoxidizers.
- (3) Percentage and analysis of pig iron for use in low carbon steels?
- (4) How are heats tested or inspected after rolling and before shipment to customers (inside or outside of plant) to determine a good or bad heat?
- (5) What causes snakes in steel? How can they be eliminated?
- (6) What is considered a good open-hearth yield on 68 per cent to 72 per cent hot metal charge, also on 40 per cent to 45 per cent pig iron charge?
- (7) Can dissolved iron oxide or manganese oxide be detected in pig iron? What effect have they on the quality of steel made from pig iron containing large quantities of either?
- (8) Cause and elimination of ferrite banding in low carbon steel?
- (9) What relationship has slag volume to the speed of a furnace and to the quality of steel?
- (10) Give the percentage and analysis of pig iron for greatest speed of a furnace.
- (11) How and when are final preliminary tests taken? How are high carbon steel samples cooled?
- (12) Methods of setting and maintaining bottoms.

November 3—Meeting 9.30 A. M.

- (13) New methods for controlling furnaces to increase speed and life of furnace.
- (14) Difference in rebuilding costs for coke oven gas, liquid fuel, and producer fired furnaces.
- (15) What advantage to be derived from deepening checker chambers?
- (16) How many checker bricks are salvaged on a general repair? Is brick cleaning advisable? How cleaned?
- (17) What practice followed in regard to air spaces between slag pocket walls and regenerators? (not discussed) How prevent curtains in air uptakes?
- (18) What is the temperature at the rear peep hole in air chamber at tapping time of heat?

(19) Fuel practice—B. T. U. per ton including heating up, and ladle and spout heating. What percentage loss figured on coal practice due to producer operation?

(20) When should a new roof be installed?

November 3—Meeting 2.00 P. M.

(21) Isley furnace.

(22) Refractory practice.

(a) Raw dolomite vs. burnt dolomite.

(b) Domestic vs. Foreign magnesite.

(c) Use of chrome ore for patching jambs and tap-holes.

(23) Relationship of mold analysis to mold life.

(24) Discussion of furnace questionnaire.

(25) Problems for spring meeting.

November 4—Visit to Ford's River Rouge plant.

Most if not all of these questions are live ones, and confront every open-hearth executive. The intent and purpose of the open-hearth committee meetings is to view these questions in the light of experiences and it is evident that such an exchange of experiences will prove beneficial to all who take part in the exchange.

Owing to the absence of the gentleman who was to introduce the discussion on the use of preheaters the topic of pit practice was brought up instead. The discussion was opened by the reading of a paper by G. D. Trantor, on pit practice at the plant of the American Rolling Mills Company, at Middletown, Ohio. Another paper on the same subject was read by J. M. Hughes, Sharon Steel Hoop Company, Sharon, Pa.

The next question—Open or Rimming Steel Manufacture—was opened by Mr. H. A. Young, Allegheny Steel Company. During this discussion a member from Hamilton, Ontario, Canada, showed tests on gas coming from rimming steel ingots, also from killed steel ingots. In both cases the volume of gas expelled was assumed to be many times the volume of the ingot and, to say the least, this information, though meager, surprised all who have not studied the condition. Research to discover means of measuring the gas that is expelled from a solidifying ingot, and means of accurately analysing the gases, is promised for the immediate future, and while such a study may not lead to corrections in steel making practice, the result will be interesting from a scientific viewpoint.

Question 3—percentage and analysis of pig iron for use in low carbon steel heats, overlapped with 2-c. with No. 7, with No. 8, with No. 9, and with question 10, because they are all related. In discussing these questions the fundamental principles of the basic open-hearth process as well as some of the laws of metallurgy were revised. Some principles of blast furnace operation were also discussed in relation to the above questions, and it was remarked that blast furnace operators might be invited to attend the meetings.

The subject of preheaters for heating air before it goes into the regenerative system was brought up at the 2.00 P. M. session Wednesday. It was shown that only a small part of the waste gases are required to preheat the air, and that the remainder can be used to generate steam without one installation interfering with the other. It was claimed that a reduction of fuel cost is possible with the preheaters installed.

Methods of setting and maintaining bottoms proved to be questions on which the members very nearly agreed as to the proper procedure in starting a new bottom, and bringing it to completion. However,

when the question arose as to whether domestic magnesite is as good as imported magnesite for making bottoms opinion was divided; some advocating the use of American magnesite and others claiming that imported magnesite is superior. In this connection the question was asked whether magnesite would be more generally used if a substantial reduction in price could be made. The answer to this question was that magnesite would never take the place of dolomite for making up the slag line after heats are tapped. And it seemed to be considered a waste of material to use magnesite on the slag line because time cannot be taken to allow it to sinter, and used as a filler it is no better than calcined dolomite.

A very interesting paper, illustrated by lantern slides shown, described the Isley furnace control. By using fans to expel the products of combustion on the outgoing end, and inducing air to enter at the point where the junction is formed between the flue and the stack on the incoming end the fan does away with the stack or chimney. Some furnaces have been equipped with this mechanism and their performance will be watched with interest.

In discussing relationship of mold analysis to mold life it was shown that very little change in iron analysis for ingot molds has been made in recent years. Mold manufacturers have always endeavored to keep the sulphur down in the iron that is used to make the mold so that the molds can be melted in open-hearth heats when they wear out. Bessemer iron is used to make ingot molds.

Ford's River Rouge Plant Visited

On Friday, November 4th about 30 or 40 of the Committee membership went to River Rouge and inspected the plant there.

Electric Mold Drying Unit

An electric heating unit for drying large sand molds in brass, steel or iron foundries has been designed by the General Electric Company to obviate the attention required by the usual kerosene lamps, stoves, coke or coal fires usually employed. Use of the new unit is expected to minimize attention and labor required by other methods in cleaning molds after drying.

The electric device consists of a helicoil, sheath-wire unit cast into iron. The terminals are protected by a cast-iron cap with an insulated hole in it, through which lead wires may be brought. Asbestos lead wire is recommended for use with the unit to withstand heat.

As the electric unit will operate directly across the line voltage, any number required in a mold may be used. A suitable hook is provided at the terminal end by which the heater may be supported in deep molds. In shallow molds where the heater must be laid horizontally, it should be supported on metal blocks to prevent its touching the sand and thus causing the heater to over-heat and spoil the mold. It is also recommended that a sheet metal cover be placed over the mold during drying to speed up the process and reduce heat losses.

The new unit is rated 1250 watts at either 110 or 220 volts. It has a shipping weight of approximately 10 lb. and the following dimensions: Overall length, 21 in.; length of heating surface, 18 in.; width, 2¼ in., and thickness, 1 in.

Technology Problems of the Steel Industry*

Attention Is Directed to the Investigations Now Under Way to
Make More Efficient the Production and Utilization of the
Raw Materials Necessary in the Manufacture of Steel

By WILLIAM A. FORBES†

THERE is probably no more important unit of the steel industry than the technological. Technology, in its simplest conception in industry, is the transforming process whereby natural resources are modified, through a series of physical and chemical operations, into commodities required to satisfy the needs of the community. The technologists develop the way for this progress, by demonstrating in laboratory and experiment what can be done, and are ably followed by the civil, mechanical, and electrical engineers in designing plants and machinery, which will make economical production possible. It is impossible to draw a line between science and engineering, for the two intermingle and the transition from pure science to practical engineering is very gradual. The chemical engineer probably represents the liaison officer between the scientist and the practical engineer.

It is the specific purpose of this paper, to throw some light upon some of the numerous major problems which confront our metallurgists, chemists and technicians, whose activities are primarily in the province of ferrous metallurgy.

The steel industry, with inherent modesty, has not made a practice of proclaiming its accomplishments in the solution of these problems, and consequently has not perhaps been accorded by the public at large, the credit due the steel industry for the wonderful work it has accomplished in this direction. Many industries of more recent birth, owing their commercial usefulness to technological development, but appearing more spectacular in the public eye, have been favored better in this respect of publicity.

We may point out that, naturally, to create entirely new processes in iron and steel is much more difficult than in the newer industries, which in their developments, have in many instances drawn on the examples and experiences afforded by the progress accomplished in the steel industry.

Chemical control on a large scale has always been credited to the iron and steel industry and the results therefrom have made possible its tremendous growth. Advancement in present-day transportation facilities, namely, railroad, steamship, automobile and aeroplane, are all rendered practicable by technological studies of the enhanced duties required of these facilities.

We wish to re-affirm our definite acceptance of the fact that the steel industry has always realized that it exists in the "Age of Chemistry," and that science is the intelligence department of all manufactures, without which this industry, like others, would at once become moribund.

In order to accomplish uniform and satisfactory results in chemical control of all raw, intermediate,

and finished products, it is obviously necessary to have standard methods of analysis, and to this end permanently organized chemists committees have been meeting periodically. Since 1914, the chemists committees of an important steel interest have published seven official pamphlets covering as many subjects, as follows: Iron and Manganese Ores; Coal, Coke and By-Products; Sampling and Analysis of Pig Iron; Fluxes, Cinders and Refractories; Gases; Alloy Steels; Ferro-Alloys and Bearing Metals. These standard volumes of analytical methods are official and are in demand by various laboratories and universities.

Many of the analytical methods are original with these chemists, and some of the older ones have been improved to meet the present-day needs. Every chemist fully understands that all our products are improved by scientific study, and their contributions for improvement are quite too numerous to mention here in detail. Progress into other fields of analytical methods, not as yet practiced, is being made. Publication of the results of laboratory investigation and technical undertakings is withheld, until these results have been proven to be authoritative and commercially possible.

The technical staffs of our various subsidiaries also carefully test and analyze all products and materials purchased, and these test reports are submitted to the interested purchasing agents for their information and guidance. The information thus obtained is useful for discussion with the manufacturer who in turn, noting the comments or reasons of rejection, studies how improvement of his product can be accomplished. In this manner alone, the steel industry is a material educator in technology, a weighty factor which is often overlooked by the public at large.

There is a limit to which any industry can go in the direction of technological study, and the steel manufacturer constantly bears this in mind, endeavoring to keep his studies within the bounds of reasonable expectation of results.

The semi-annual meetings of this institute are instrumental in disseminating the technological knowledge and progress developed in the steel industry, and its program of technical papers constitutes the latest reviews of metallurgical improvements and engineering practices. These papers for the most part represent original work done by the authors and the subsequent journalistic reviews and discussions, afford constructive educational information to this industry whose activities are dominantly metallurgical.

Participating in these meetings, the representatives of the steel industry have since 1910 prepared and presented from this platform a total of 210 papers. They have freely contributed papers dealing with valuable scientific material and evolutionary facts, covering all phases of steel manufacture from raw materials to finished product, as well as papers on general commercial subjects and on industrial welfare, health, housing and education.

*Paper delivered before American Iron and Steel Institute, New York, October 28, 1927.

†Assistant to president, United States Steel Corporation, New York, N. Y.

This institute functions with the primary aim of acting as a centralized fact-finding and information bureau. Its leaders, in selecting these papers and their subjects, vision very carefully that the established order of today may be out-of-date tomorrow.

The technological investigation work concerned in the manufacture of steel from raw materials to finished products, is conducted largely by standing committees covering the problems involved. These are augmented by intercompany and works committees, which meet regularly for the discussion of their specific technical and operating problems. The chemical and physical laboratories of any individual company or plant co-operate with others, when desirable, to perform the scientific work detailed for them. Those problems passing the laboratory stage are, when sufficiently promising, experimented with on a larger scale at the plant best adapted for the purpose. Upon completion of laboratory, and these larger scale tests, all theoretical, practical, and commercial phases of the question are discussed by the proper committee and interested executives regarding its application in the industry, and if the decision of this council is favorable, the method, process or plant is developed into the operating stage.

In the matter of patents, great encouragement is always extended to the employees of all classes to invent new methods, processes and labor-saving devices. The employees of an important steel interest have since January 1, 1917, been granted at Washington, D. C., a total of 762 patents pertaining to the steel industry, of which 252 or 33 1/3 per cent of the total are classified as pertaining to metallurgy and chemistry.

It has been considered wise not to patent, for the sake of patenting alone, what appear to be far-fetched and unworkable systems, but only those which give promise of practical operating value. Many improvements, instituted and developed by our workers, have not been patented, but have been introduced into our practices without ceremony and with suitable recognition to the originator.

Many production advantages and ideas have been distributed freely to other manufacturers, without thought of other compensation than the benefits of mutual co-operation.

That the idea or process of the inventor must be sound and practical, and pass the judgment of many executives before the application is made, is testified to by the small percentage of applications rejected; approximately five out of six patents applied for are granted.

The technological principles underlying the selection of suitable raw materials for the by-product coke ovens and the blast furnace, the operation and tonnage development of the by-product coke oven and blast furnace, open-hearth furnace, bessemer converter and electric furnace, alloy steels and finished products, have been largely instrumental in the continuous progress of the steel industry of the world.

Take railroad transportation as an example of technological improvement, and it is easily realizable that, without the intelligent study of the metallurgist and chemist, rails could not have been developed to carry the heavy loads now demanded. It is true that the carbon saturation point of rails, in the heavier sections, has now apparently been practically reached in specifications set up by the railroad companies, but the technologist continues his work of over-

coming this handicap with excellent prospects of success in the comparatively near future.

We will now bring to your attention a few specific examples of technological study which have been, or are being, made. Subjects have been selected so as to represent the various stages of steel manufacture, from raw materials to finished product. Incidentally, I may say that, for the reason of my position with the United States Steel Corporation, the data presented are largely drawn from the studies and observations of the technical personnel of that organization.

Iron Ore

In 1926, the Lake Superior District produced approximately 85 per cent of the iron ore mined in the United States, from its seven different districts, or so-called iron ranges, which are distributed along the south and west borders of Lake Superior, in Minnesota, Wisconsin and Michigan. The Missabe Range mining problems have required the most attention.

Missabe Range Mining Problems—The ore bodies of the Missabe Range are relatively flat-lying, and have a large surficial area and relatively shallow depth, as compared with ore bodies of most of the other iron ranges of the Lake Superior District. They also consist of four major layers or horizons, each of which contains from two to four subdivisions of ore of different grade and texture. They are covered by an overburden of glacial drift, varying in depth from a few feet to 150 ft. or more. The problems, then, are those of proper methods of extraction of such flat-lying ore deposits, and of grading, due to the varieties of ore met with at different contiguous horizons. Because of the above described physical conditions, most of the ore bodies can be, and are, developed by open-pit methods, at least to the point where the cost of mining by such methods equals, or slightly exceeds, the cost of underground operations.

Open-Pit Operations—In the removal of the glacial drift overburden and the subsequent ore mining operations, suitable practical and economical machinery is required, consisting of shovels, air dump cars, suitable rails and locomotives of high tractive power. The shovels vary in size from 30 to 350 tons, the stripping cars from 20 to 30 cu. yd., the locomotives are standard gauge varying in size up to 100 tons. The shovels used are either electric or steam shovels. Under some conditions, also, dragline machines are being used. Ore cars are of 50 tons and 75 tons capacity.

The mining problems in the open-pit operations necessitate planning and installation of adequate track systems for the removal of both stripping and ore, proper locations for waste and lean ore disposal, yards for storing and sampling of loaded ore cars, mechanical shops and plants, and other items arranged so as to permit of the greatest economy and convenience.

The whole operation is practically one of mass production, delivering at the same time a variety of grades of ore assembled from a number of places from the interbedded strata of ore, ore-material, and waste, all of which must be moved, sorted and disposed of as the character of the material demands.

The problem of producing the different grades of ore required for furnace use, is one of the most difficult of the open-pit mining problems, requiring the proper manipulation of steam shovels and track grades to select the ores from the various sections needed.

(To be continued)

Synchronous Motors for Driving Mills*

The Conditions to be Met in Different Types of Mills Are Discussed After Which the Characteristics of Various Classes of Motors Which May be Applied Are Considered

By W. T. BERKSHIRE and H. A. WINNE†

TO everyone who is familiar with present-day tendencies in the application of electric motors in industrial power service, a very decided trend toward the increased use of synchronous motors is evident. Not so many years ago we thought of using them only as parts of motor-generator sets, or in similar comparatively "easy" service, that is, easy as far as starting and synchronizing are concerned. In recent years, however, the desirability of improving the power factor of industrial loads has focused attention on the synchronous motor. The designing engineers have met the demands for better starting characteristics, and today we find such motors applied to constant speed drives of almost all kinds, including cement and paper mill grinders, rubber mills, and steel mills.

It is the purpose of this paper briefly to discuss, from a practical standpoint, the application and design of synchronous motors for steel mill main roll drives, in an effort to show what their advantages and disadvantages are; where they should, and where they should not, be used; and what special precautions must be taken in the design of motors for this service.

Types of Mills

Perhaps for the benefit of those who are not familiar with steel mill practice it may be well to define the term "steel mill main roll drives," and very briefly to describe some of the types of mills met with. The "main rolls" are those between which the steel is passed in order to bring about a reduction in area or a change in shape, and it is in the drives for these rolls that we are particularly interested. These are termed "main drives," as distinguished from the "auxiliary drives" which operate roller tables on which the steel is carried, chain transfers, and other apparatus for handling the steel.

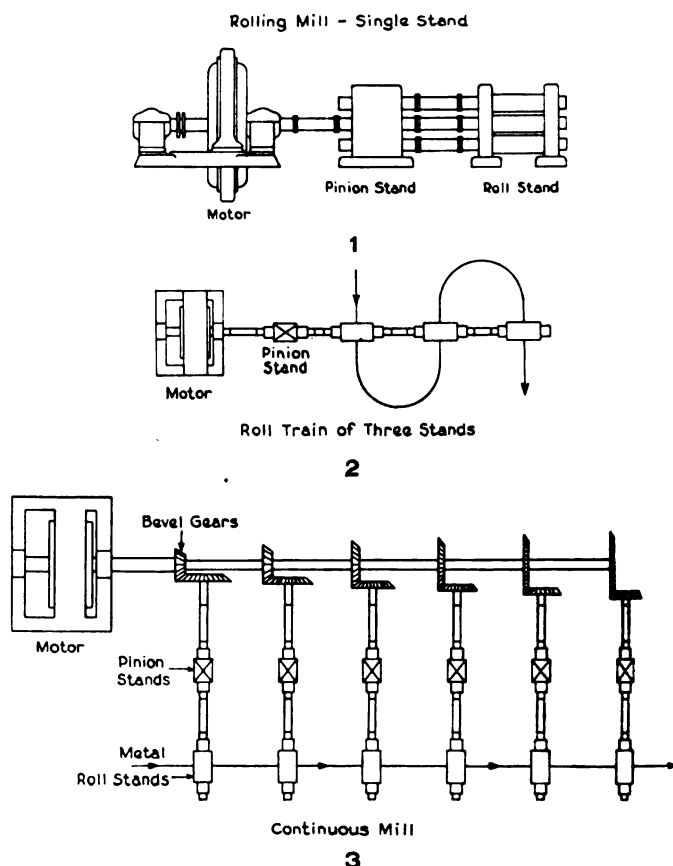
A rolling mill consists of one or more "stands" of rolls, which may be "two" or "three-high." A mill consisting of a single stand of rolls is shown in Fig. 1. This is a "three-high" stand, as there are three working rolls, one above the other. These three rolls are driven through the pinion stand from the motor, which is shown direct connected, but may be geared to the pinion stand. The middle roll rotates in one direction, and the other two in the opposite. In the course of the rolling operation the metal may be passed through the mill in one direction between middle and bottom rolls, and then back between top and middle. This may be done several times in the same stand, the section of the metal being reduced and possibly its shape changed, in each pass. This is accomplished by having "grooves" of different shapes along the length of the rolls.

A "two-high stand" has only two rolls, and therefore unless the mill is of the reversing type, the metal is usually given only one "pass" in such a stand.

*Paper delivered before the American Institute of Electrical Engineers, November 29, 1927.

†General Electric Company.

A number of stands of rolls may be connected in a "train," as in Fig. 2. In such a mill, if the section of the metal being rolled is sufficiently small, it may be "looped" from one stand to another as shown, passing between the bottom and middle rolls and between the top and middle rolls in alternate stands.



A "continuous" mill consists of a number of two-high stands, arranged so that the metal passes in a straight line from one to another, sometimes being in several stands at once. The various stands may be driven from a single motor through a layshaft and bevel gears, as in Fig. 3, or by individual motors.

Some mills run at constant speed, while others have provision for speed adjustment, to facilitate rolling of varying products. A few reverse after every pass, but the majority run normally in one direction only.

Duty Required of Main Roll Drives

Driving main rolls is universally recognized as very heavy duty. The loads are high, and are applied and relieved very suddenly. Consider the case of a motor driving a single stand. Between passes it will run with only 5 per cent to 10 per cent load, due simply to mill friction. As the metal strikes the rolls the load jumps almost instantly to possibly 100 per cent or 150 per cent of normal, and is as suddenly reduced when the metal leaves. This happens several times a minute.

If such a drive has been properly selected, several passes on each bloom or billet may require 150 per cent to 175 per cent normal load on the motor. The load is intermittent in character, so that the motor is selected with the idea of permitting some of the passes to come up to these limits, so long as the root-mean-square value of the load is within the normal rating of the motor. If the heavier passes are of not more than three or four seconds duration a flywheel may be utilized to reduce the peak loads on the motor and power system.

With mills of the types shown in Figs. 2 and 3 the drive is not subjected to quite as severe shocks as with a single stand, for it is apparent that as a piece of metal enters the mill stand number one is first filled, then stands one and two, and so on until all stands are full; that is, the load increases to the maximum value in a number of steps, and is similarly reduced.

The torque required to start a mill from rest is often quite high in comparison to the capacity of the driving motor. This is especially true in cold weather, as very heavy grease is used on the roll necks and pinions, and this becomes very hard at low temperatures. Mills used for cold rolling thin sheets, which operate with very high pressure between the rolls and consequently on the bearings, may require as much as 200 per cent of normal torque to break them loose.

In addition to being able to start the mill, and carry heavy and sudden overloads, the drive must usually be capable of withstanding "plugging" in order to bring the mill quickly to a stop in case of a "cobble" or other mishap. Any piece of metal which fails to go through the mill properly is termed a "cobble." As soon as the operator sees that the steel is not going through as it should, he "plugs" the motor, by disconnecting it from the line and then applying power with reversed phase rotation. After the mill stops, if the metal is not clear of all the stands, the portions between stands are cut out with the cutting torch, and then the motor must start the mill in the reverse direction to back out the pieces in the rolls.

Considering all these conditions which a main roll drive must meet, it is not remarkable that for nearly all constant speed electric drives induction motors of the wound rotor type have been used. This type of motor has excellent starting characteristics, will carry heavy overloads, and withstands much abuse. In common with all induction motors, however, its power factor is lagging, and very much so in slow speed machines. Now the main rolls and lay-shafts on heavy mills do not run at high speeds, and it is often desirable to direct connect the motor, so that there are now in service many slow speed motors, operating at low power factors. As a matter of fact, one reason for the use of 25 cycle power in numbers of steel plants is that slow speed 25 cycle motors have better power factor than the corresponding 60 cycle machines. The use of higher speed motors driving through reduction gears has helped the situation somewhat, but has still left much to be desired in the way of power factor improvement.

Comparison of Synchronous and Induction Motors

Unquestionably the desire for a better operating power factor has been the chief factor in bringing the synchronous motor into consideration as a competitor of the wound rotor induction motor in steel mill service. However, it possesses advantages other than its good power factor, as well as some disadvantages,

and these will be brought out in the following detailed comparison of the characteristics of the two types of machines.

Starting Characteristics Practically the only reason synchronous motors have not been widely used on mill drives in the past is because their starting characteristics are not so desirable as those of the wound rotor induction motor. For 100 per cent kv-a. input the induction motor develops approximately 100 per cent rated torque at starting, whereas the synchronous motor will give from 30 to 60 per cent starting torque with the same kv-a. input at a much lower power factor. However, the torque obtainable from a synchronous motor is ample to start most types of mills, and its other advantages make it the logical choice in many cases.

By proper design, good starting torque characteristics, as shown in Figs. 4 and 5 can be obtained in mill type synchronous motors with a single squirrel cage winding. The double squirrel cage has, at times, been considered. But in each case it has been found that by the proper choice and distribution of materials in the bars and rings, the proper spacing of the bars with respect to the stator slot pitch and the depth and width of the slots in the pole face over the bars, the torque requirements have been amply met with a single squirrel cage. In practically all cases it has been found possible to obtain more than sufficient torque to start and bring the mill to synchronous speed, or to even back out a cobble, with from 70 to 100 per cent normal kv-a. input. Unlike that of the squirrel cage induction motor the squirrel cage of the synchronous motor can be changed in design at will, with a corresponding change in torque characteristics, without affecting the efficiency of the synchronous motor during its normal operation under load.

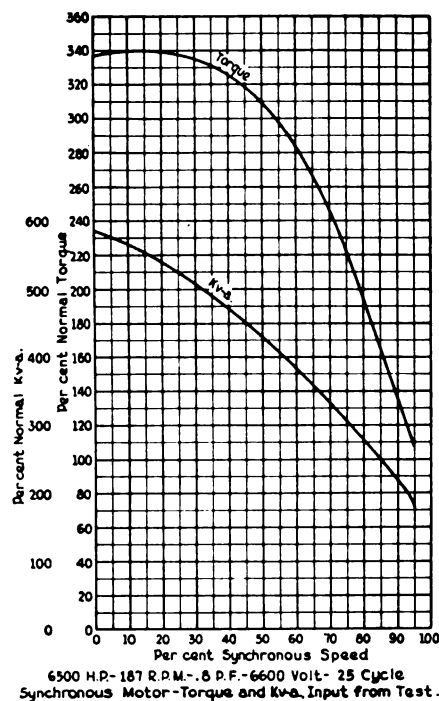
The curves shown give the torque and kv-a. values with full voltage applied to the motor. In normal operation of course, these large motors are started at reduced voltage obtained from a suitable auto transformer. For example, the 6,500-hp., 187-rpm. motor for which starting torque and kv-a. curves are shown is regularly started on 32 per cent voltage. Since the starting torque and kv-a. input varies as the square of the voltage, it is apparent that under this condition the motor demands only 60 per cent of normal kv-a. and gives about 35 per cent of its normal torque. This has proved ample to start the mill under all conditions. Similarly, a 9,000-hp., 107-rpm. motor is always started at 32 per cent voltage, giving 27 per cent of normal torque with 70 per cent normal kv-a.

The "pull-in" torque, or the torque available at approximately 95 per cent synchronous speed before the application of field, must of course be in excess of the mill friction at this speed, but can be considerably less than the starting torque, as the latter must overcome the "dead" friction of the mill, with the bearings practically dry.

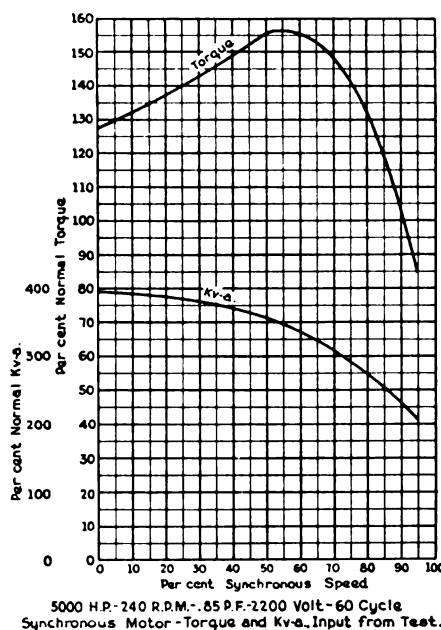
The fields of these motors are usually wound for 250 volt excitation, and if the field were left open circuited at starting the induced voltage across the rings, with 33 per cent normal voltage applied to the stator, would be from 5,000 to 10,000 volts. In order to protect the operators from the induced field voltage it is the practice when starting, to close the field circuit through a discharge resistance. While this increases the starting current and decreases the starting torque to some degree, it also increases the pull-in torque. The amount and capacity of this resistance to

give the best torque characteristics can be determined by calculation.

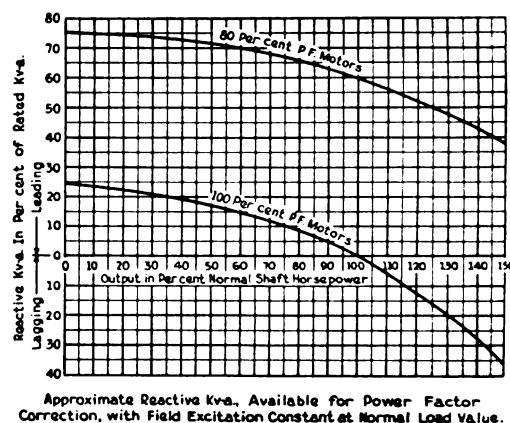
A synchronous motor may be plugged for a quick stop, by first opening the "forward" breaker and removing field, then closing the "reverse" breaker and connecting the motor to the starting tap of the auto-transformer. The current drawn when plugging is approximately 15 per cent more than the starting current, and the torque developed about 75 per cent of the torque at starting.



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Maximum Torque—A synchronous motor can be designed for fully as high maximum or pull-out torque as an induction motor and for steel mill service this pull-out torque varies from 225 to 300 per cent of normal full load running torque. The synchronous motor has the advantage that for any reduction in applied line voltage the pull-out torque decreases only in direct ratio to the voltage, whereas the torque of an induction motor decreases as the square of the voltage. Furthermore, because of its better power factor, the synchronous motor helps to maintain the voltage at its terminals; consequently the drop in line voltage due to a given load is not likely to be so great as if an induction motor were used.

Power Factor—One of the most desirable features of the synchronous motor is its ability to improve the power factor of the system on which it operates. It is usually designed to give a leading power factor at normal load, and will then furnish a considerable amount of corrective kv-a. at all loads up to a considerable overload, as shown in Fig. 6. The low power factor of slow speed induction motors, particularly 60 cycle machines, has necessitated the use of reduction gears in some cases where for other reasons a direct drive would have been preferable. The use of synchronous motors permits direct drive with slow speed machines, operating at unity or leading power factor.

Efficiency—Two curves are shown, illustrating the very high efficiency obtained from large synchronous motors both 25 and 60 cycles. The fact that approxi-

mately 75 per cent efficiency is obtained at 5 per cent of normal load is quite noteworthy.

The full load efficiency of synchronous motors for steel mill service varies from 0.5 to 2 per cent more than that of the corresponding induction motors. This better efficiency of course means some saving in power cost.

Operating Voltage—Synchronous machines can very readily be built for any operating voltage up to and including 13,200. While a very few induction motors are

operating at 13,200 volts, it is better practice not to exceed 6,600 volts on an induction motor, as the design becomes difficult and the machine expensive.

Excitation—One disadvantage of the synchronous machine is that it requires a separate source of excitation, while the induction motor does not. On an important drive it is wise to employ an individual exciter, either direct connected or driven by a separate motor. The excitation voltage is always 250, so that as an emergency source the 250 volt d.c. power circuit which exists in all steel mills can be used.

Floor Space—The amount of floor space required by a synchronous motor is almost invariably less than that needed for an induction motor of the same rating. One reason for this is that it is the usual practice to make the motor base long enough so that the stator can be moved along the shaft a sufficient distance to make both rotor and stator windings accessible for cleaning or repairs. The rotor of an induction motor is inherently somewhat longer than that of a synchronous motor, because of the space required for the end connections of the coils on the former, and this necessitates a greater space for movement of the stator.

Table I shows the relative base dimensions of the two types of motors, for several different ratings.

Speed Control—Control, or rather adjustment of the speed of a synchronous motor in mill service is of course impractical, and its use must, therefore, be confined strictly to constant speed mills. This fact also

TABLE I—FLOOR SPACE

Rating	Synchronous Motor		Induction Motor	
9000 hp., 107 rpm., 25 cycles.....	18 ft. 0 in. x 24 ft.	8 in. = 445 sq. ft.	20 ft. 7 in. x 25 ft. 0 in. = 515 sq. ft.	
6500 hp., 187 rpm. 25 cycles.....	17 ft. 5 in. x 15 ft.	7 in. = 272 sq. ft.	16 ft. 7 in. x 19 ft. 3 in. = 319 sq. ft.	
5000 hp., 100 rpm., 60 cycles.....	13 ft. 2 in. x 21 ft.	11 in. = 288 sq. ft.	16 ft. 8 in. x 23 ft. 11 in. = 398 sq. ft.	
5000 hp., 240 rpm., 60 cycles.....	13 ft. 8 in. x 14 ft.	2 in. = 195 sq. ft.	14 ft. 0 in. x 16 ft. 0 in. = 224 sq. ft.	
5000 hp., 83 rpm., 25 cycles.....	14 ft. 3 in. x 19 ft.	9 in. = 282 sq. ft.	15 ft. 0 in. x 20 ft. 0 in. = 300 sq. ft.	
1500 hp., 300 rpm., 25 cycles.....	10 ft. 10 in. x 11 ft.	8 in. = 123 sq. ft.	12 ft. 3 in. x 11 ft. 9 in. = 143 sq. ft.	

eliminates it from consideration on any so-called constant speed mill on which a flywheel is necessary, for to get any beneficial effect from the wheel the speed must vary inversely with the load.

The fact that the motor runs at truly constant speed, except for what variation in frequency occurs on the system, is an advantage on some types of mills. For example, if the product from a continuous mill of the type shown in Fig. 3 is cut into lengths by a flying shear, as it leaves the mill, the lengths will be more uniform if the mill speed is absolutely constant than if it varies slightly.

Cost—The cost of a synchronous motor, of the capacity used for main roll drives, complete with exciter and control, is usually less than that of a similarly rated induction motor. For machines of medium capacities, speeds and voltages, the differential is not great, but for large slow speed units, the synchronous machine is considerably less expensive.

Reliability and Ease of Repair—From the standpoint of reliability it can hardly be said that either type of motor has the advantage. A machine any more reliable than the well built mill type induction motor has proved itself to be would be hard to find, but there is no reason why the synchronous motor should not have an equally good record in the years to come.

As far as ease of repairing is concerned, the stators of the two machines are practically on a par. The coils of the synchronous motor are somewhat larger and heavier as a rule, but there are fewer of them. The rotor of a synchronous motor could probably be repaired more quickly than that of an induction machine. The fact that the synchronous motor has a fairly large air gap helps to facilitate the moving-over of the stator for cleaning or repairs.

Construction—Obviously the details of design and construction described in the following paragraphs apply to motors built by the company with which the writers are associated. The practice of other manufacturers may differ in some respects.

The mechanical and electrical construction of the mill type synchronous motor is fully as rugged and reliable as that of the mill type induction motor. The quantity and kind of the materials used are such that all stresses are kept within a conservative minimum.

The stator frames of the earlier motors of this type are of cast iron. Those built within the past year and a half, however, are fabricated of steel plates securely welded together and braced to form an exceedingly strong and rigid structure. To the inner periphery of the frame are welded steel dovetailed keys. The core laminations are held on these keys and clamped between heavy welded steel finger flanges. Air ducts are provided in the core and complete ventilation is further accomplished by the use of air slide wedges.

Because of the size and weight of the stator coils in these large motors they are insulated very care-

fully to protect them from mechanical injury. After their assembly in the stator the end projections are securely laced to insulated steel bracing rings which are supported from the stator frame. The larger machines are supplied with resistance temperature detectors. The stator coils are liberally designed to safely take care of sudden overloads or the condition where the motor may be required to develop its maximum torque as an induction motor.

The rotor spiders of the machines of small diameter are built up of laminations punched from heavy steel plates, those of larger diameter being of cast steel. The laminated pole pieces are either dovetailed into the punched rotor or secured to the cast rotor by means of bolts screwed into steel keys imbedded in the pole pieces.

The field windings are usually of edgewise-wound copper strip. Here again great care is given to the insulation between the turns of the winding, and of the coils as a whole from the pole pieces and rotor spider. One of the recent improvements in design consists in the addition of fins to the ends of the field coils which are made by simply projecting every second or third turn during winding. These fins provide an increased area of radiating surface on the ends of the coils and have proved very effective in reducing the field temperature.

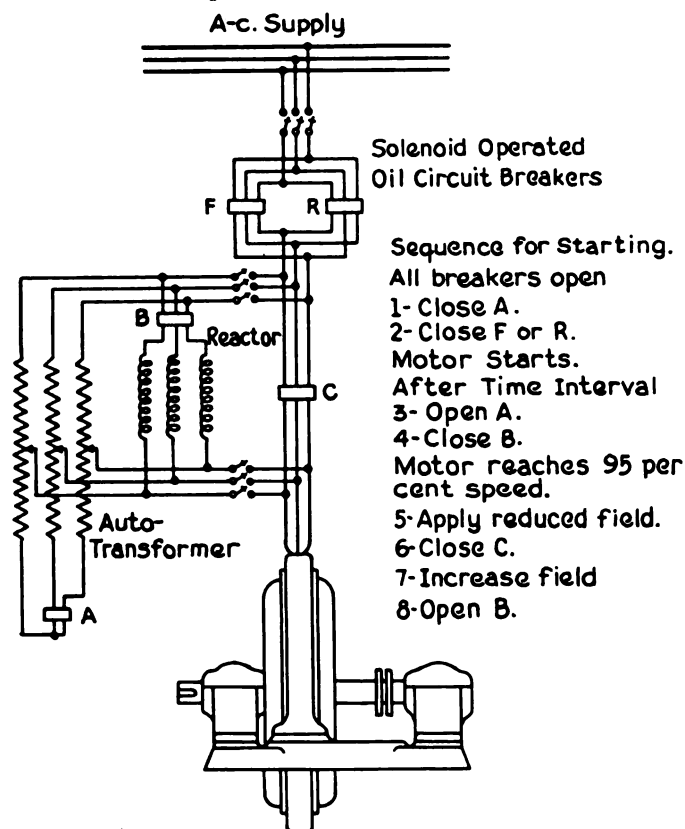
Since these motors may, at times, be required to develop their maximum torque as induction motors, considerable attention is given to the heat storage capacity of the amortisseur winding, the materials used being such that their strength will be retained at high temperatures. The bars are silver soldered into the end ring segments. The end ring segments have bolted joints between poles so that each individual pole may be readily removed from the rotor without disturbing the others.

The specially designed mill type pedestals are securely bolted to both the base and foundation. They are equipped with babbitted thrust collars when this feature is desired. These pedestals are insulated from the base to eliminate the possibility of shaft currents. The spherical seat, self-aligning bearings may be equipped with temperature relays. A liberally designed ring oiling system insures ample lubrication, but in addition, provision is made so that flood lubrication may be applied.

The base is provided with rollers under the carrier plates supporting the stator feet in order that the stator frame may be easily moved in a direction parallel to the shaft. The carrier plates are keyed to the base in order to maintain the alignment of the stator frame during this movement.

Air heaters may be installed in the lower halves of the stator frames of these motors to prevent the possible accumulation of moisture on the windings in case the mill is idle for any considerable length of time.

Control—A few main roll synchronous motors are started at full voltage, but most of them are so large that such practice is not desirable because of the resulting demand on the power system. Consequently, an auto transformer is usually employed to give reduced voltage for starting. For some of the largest machines it has proved desirable to employ two reduced voltage steps in the starting operation, and to meet this condition the combination Korndorfer and reactor method illustrated diagrammatically in Fig. 7 has been developed.



Combination Korndorfer and Reactor Method of Starting Synchronous Motors.

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The sequence of operation for starting, stopping, or plugging the motor is initiated by the simple movement of the handle of a master switch placed near the mill, and the operation is completed automatically under the control of relays on the control panel.

We will assume that the motor is at rest and that the operator throws the handle of the master switch to the "Forward" position. Oil circuit breaker "A" closes at once, establishing the neutral connection of the auto transformer. "F" follows immediately, connecting the line end of the auto transformer to the line and thereby applying the first step of reduced voltage to the motor. With this voltage the motor should start and gradually increase its speed.

When it reaches a predetermined speed, usually from 50 to 75 per cent of synchronism, as indicated by the frequency obtained from a small pilot generator on the main motor, a relay operated in response to the frequency causes breaker "A" to open, and immediately thereafter breaker "B" closes. "B" connects the motor to the line through the reactor. The reactor

is so proportioned that the voltage drop across it at the time it is connected in the circuit is sufficient to reduce the voltage at the motor to a value between the line voltage and that given by the auto transformer tap. As the motor speed increases, the current will drop and the voltage at the motor terminals will rise.

When the motor reaches approximately 95 per cent synchronous speed, as determined by a relay which operates only when the difference between the line frequency and the pilot generator frequency is 5 per cent or less, field excitation is applied, or sufficient value to give approximately unity power factor. This pulls the motor into step, and so reduces the current drawn by the motor through the reactor that the voltage at the motor terminals increases almost to the line value.

After a short time interval, breaker "C" closes, "B" opens, and the field excitation is automatically increased to the full value.

It will be noted that at no time during the sequence of starting operations is the motor entirely disconnected from the line. Furthermore, owing to the use of the reactor, the transition from the second starting voltage to the line is made with extreme smoothness.

One of the illustrations shows the master relay panel for such a system of starting. It should be noted that this particular panel contains a push button, triple pole contactor and overload relays used in connection with a blower motor, and a double pole switch and contactor for the heater circuit, in addition to the controlling elements for the main motor. Protection is provided against under-voltage, loss of excitation, and failure to synchronize within a definite interval after the master switch is operated.

The control equipment for a synchronous motor involves more oil circuit breakers than does that for an induction motor, but the latter requires a number of large contactors and resistors for its rotor circuit, with relays for controlling the same. Neither is especially complicated in installation or maintenance. As far as the mill operator is concerned, he simply moves the handle on the same kind of master switch to start either type of motor.

Installations

A considerable number of synchronous motors are now installed or being built for main roll service. Those supplied by one manufacturer include the following:

A 9000-hp., 107-rpm., 25-cycle, 6,600-volt unit is driving a continuous sheet bar mill at the Cleveland plant of the Corrigan-McKinney Steel Company. This motor has a higher continuous horsepower rating than any other motor in industrial service in this country.

Two motors, one 6,500 hp., 187 rpm. and the other 4,000 hp. 83 rpm., 25 cycles, 6,600 volts form part of the drive of a continuous skelp mill at the Bethlehem Steel Company's Sparrows Point plant.

A 5,000-hp., 240-rpm., 60-cycle, 2,200-volt synchronous motor is being installed to drive a tube piercing mill at the Standard Seamless Tube Company's plant at Economy, Pa.

The Continental Steel Corporation, Kokomo, Ind., has purchased a 5,000-hp., 100-rpm., 60-cycle, 2,200-volt motor to be used in driving a continuous sheet bar mill.

The Copperweld Steel Company of Glassport, Pa., will use three 60-cycle, 2,300-volt synchronous motors.

(Continued on page 596)

The POWER PLANT

*Powdered Coal Applied to Small Boilers**

Limitations in Design of Small Plants Make Attainment of High Efficiencies Impractical—Examples of Application of This Fuel to Small Units Cited

By HENRY KREISINGER†

THE good results that are being obtained with powdered coal in large central stations have created an interest in powdered coal among the operators of small steam plants and small boiler units of industrial establishments. The small plants are usually stoker or hand-fired, and the results are frequently far from satisfactory. The monthly operating efficiency seldom reaches as high as 70 per cent. When the operators of the small plants hear of the high efficiencies which are being obtained with large pulverized-coal installations, they feel that they should take advantage of the new developments in pulverized coal, reduce their coal bills, and increase the capacity of their plants.

Although the small plants can be benefited by the installation of powdered-coal firing, they cannot as a rule obtain the high efficiency that is obtained by the large central stations. There are certain limitations in the design and in the operation of the small plants that make the attainment of the high efficiencies impractical. This paper points out some of the limitations and gives a few examples of the application of pulverized coal to industrial plants, some of them having very small units.

It may be true that pulverized-coal burning was developed on small boilers, but most of the first new pulverized-coal installations with rational design of furnaces were made in large central stations on large steam generating units. The efficiencies obtained with some of these installations are high, averaging 88 to 90 per cent by the month. These high efficiencies were made possible because with these large units the designing engineer was justified in using such combinations of apparatus as could be operated with high efficiency. To obtain a good heat absorption the designer used large economizers or a combination of a smaller economizer and air heater. To obtain good combustion he designed large, well-proportioned furnaces with water-cooled walls. This design of furnace made it possible to burn the coal with low excess air, easy ash removal while the furnace was in operation, and small furnace maintenance.

Although with powdered-coal firing there is very little or no coal burned during banking periods, nevertheless there are losses from radiation and from heat being carried up the stack by the unavoidable flow of air through the setting. The setting is cooled off, and when the unit is started heat is put into the setting during the time it is heated to operating temperatures.

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†Research engineer, Combustion Engineering Corporation.

Improvement of Small-Plant Efficiency Generally Possible Through Use of Pulverized-Coal Firing

Generally speaking, the small-plant operator can appreciably improve his operating efficiency by using pulverized firing. However, he cannot obtain the high efficiency and the greater capacity that is obtained with the large installations. The size of his plant does not justify him in putting in the best combination of equipment such as is used in the large central stations. The cost would be prohibitive. The small-plant operator can buy only such equipment the cost of which will be justified by the size of the plant and the saving in coal that can reasonably be expected.

The small plant is usually a part of a manufacturing establishment and its financing is done on different basis as to the rate of return on the investment from that which is the case with large plants of public-utility companies. The calculations on the costs and possible returns with the industrial plant must show frequently nearly double the rates of the public-utilities returns before financial backing can be obtained. As a result of this different basis of financing, many of the industrial plants must go without economizers and air heaters. Even the heating surfaces of the boilers may have to be reduced. Thus the products of combustion are allowed to escape at a comparatively high temperature, making it impossible to obtain high efficiency.

Factors Causing Poor Combustion Conditions

In the effort to keep the first cost down the furnaces of the small plant must forego the advantages that can be derived from air or water-cooled walls and bottoms. The furnaces may have to be built with solid brick walls and flat bottoms, which construction makes it necessary that they be operated with high excess air in order to avoid erosion of the walls and to make ash removal possible without shutting down the boiler. Such operation of course results in lower efficiency.

For the same reason of the necessity of low first cost, the storage or feeder and bin system is barred out and the direct firing system, which is admittedly less efficient, must be used. Although the direct firing under favorable test conditions can show a good efficiency comparable to that of the storage system, this good efficiency cannot be maintained over long periods of operation. Most of the mills used for direct firing are of the high-speed beater type. As the pulverizing parts wear, the capacity of the mill is reduced, and at the same time the pulverized coal becomes coarser. At

times the operator may find it necessary to hold the capacity, which he may succeed in doing at the sacrifice of fineness, with the result that excessively coarse coal is supplied to the furnace. The coarse coal does not burn completely and either falls to the bottom where it accumulates without burning completely, or is carried up the stack, thus causing high incomplete-combustion losses and low efficiency.

Another factor which may cause poor combustion condition is irregular feeding to the mill due to either excessive moisture in the coal or variation in the size of coal. A lump of coal or a piece of wood or iron may stop the feed entirely and cause the fire to go out before the operator is able to remove the obstacle from the feed, and it may then be necessary to light the fires with a torch. Such conditions increase the incomplete-combustion losses, thereby lowering the efficiency.

The small industrial plant may be operated only during the daytime and remain banked a large part of the night. If the fires in a banked boiler are started at six in the morning it may be one or two o'clock in the afternoon before the setting becomes heated and all the heat generated in the furnace becomes available for making steam instead of being partly absorbed by the setting. The heat absorbed by the setting during the first part of the day is largely lost after the boiler goes on bank in the evening. The average efficiency for the day's run may be 2 or 3 per cent lower than it is during the afternoon after the setting becomes thoroughly heated.

Loss in Operating Efficiency Resulting from Long Banking Periods

Fig. 1 is the efficiency curve of a powdered-coal-fired boiler starting from a banked condition at 6:30 A. M. and going on bank again at 4:30 P. M., remaining banked from 4:30 P. M. until 6:30 A. M., a total of 14 hours. During the 10 hours of operation the average rating on the boiler was 180 per cent. This was the regular operation during five working days in a week. Saturdays and Sundays the boiler remained banked throughout.

The boiler was a 1,000-hp. horizontal water-tube Wickes boiler at the plant of the Farr Alpaca Company, Holyoke, Mass. It was vertically fired by the feeder and bin system. The furnace walls were of the hollow-wall air-cooled construction and the bottom was cooled by a water screen. It was one of five similar boilers at this plant and was without an economizer or an air heater. It cannot be called a small boiler. It is referred to because of its comparatively short period of operation and long period of banking. Its operation illustrates the loss in operating efficiency due to long banking periods. The curve shows that the efficiency during the first two hours of operation after lighting the fires was only about 69 per cent, although after the setting became thoroughly heated it reached 81 per cent. The weights of the coal burned and the water fed to boiler were determined by actual weighing for each two-hour period. Fifteen such tests were

made, and all of them gave an efficiency curve similar to that shown in Fig. 1. It is safe to say that had the boilers been fired with stokers the operating efficiency would have been much lower, although when compared with the operating efficiency of some of the large central stations, the efficiency of this boiler appears low.

It may appear that the substance of this paper is an argument against the application of powdered coal to small industrial boilers, but such is not the case.

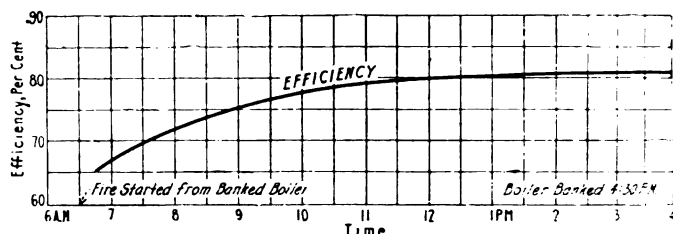


FIG. 1—Efficiency curve of a 1000-hp. horizontal-water-tube powdered-coal-fired boiler starting from banked condition.

The author is merely pointing out some of the reasons why the owner of a small plant with small boilers cannot obtain the high efficiency that is obtained in some of the large central stations. If the small-plant operator with his low-cost equipment and unfavorable operating conditions were made to believe that by the use of pulverized coal he could obtain as high efficiency as the large plant, he would be doomed to disappointment. He should realize that with his equipment and his unfavorable operating conditions, 75 per cent operating efficiency is quite creditable, and cannot be obtained by other methods of firing.

Typical Installations of Powdered Coal Under Small Steam Boilers of Industrial Plants

The following illustrations show five typical installations of powdered coal under small steam boilers of industrial plants.

Fig. 2 shows an installation of powdered coal under a horizontal tubular boiler having 1,830 sq. ft. of heating surface. It is one of two similarly fired boilers at the nursery of A. H. Budlong, Chicago, Ill. The boilers supply steam for heating glass houses and for pumping water for irrigation purposes. The heating season is 10 months long. Steam is also used on cold nights during the remaining two months.

Coal is pulverized by a Raymond impact mill driven by a steam turbine. The pulverized coal is discharged directly into the furnace and burned by means of a Leach burner. The operating rate of combustion varies from 235 to 1,100 lb. of coal per hour. The ex-

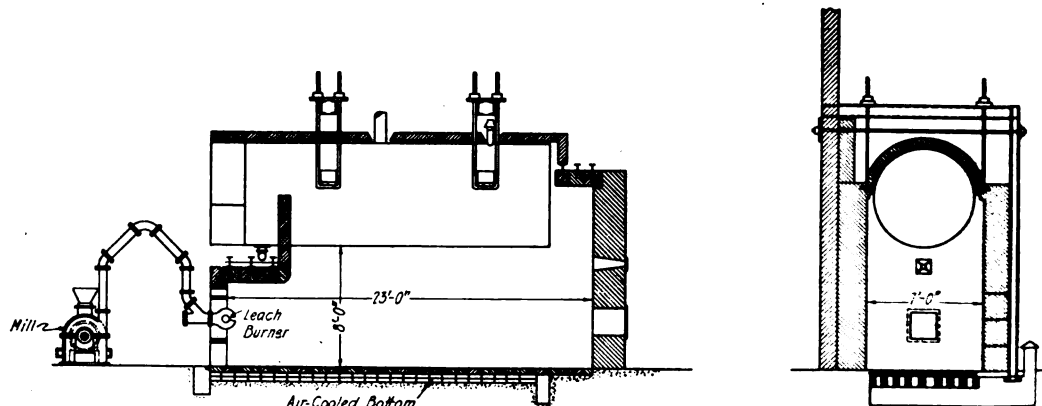


FIG. 2—Application of powdered coal to a horizontal return-tubular boiler.

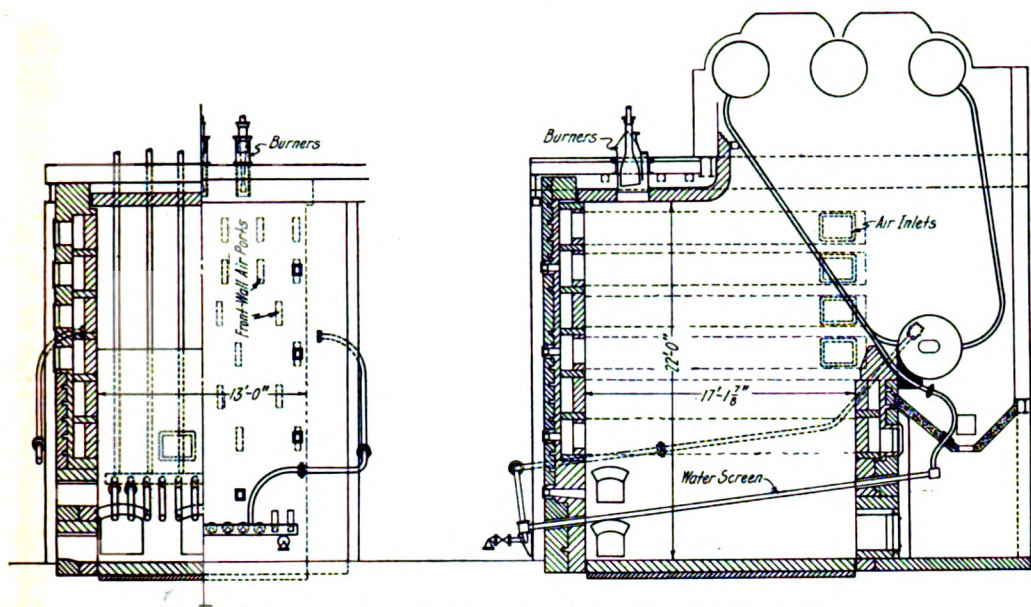


FIG. 3—Application of powdered coal to a Stirling boiler.

haust steam from the turbines driving the mills is used in the heating system.

The boilers are kept in service about three months at a time before they are taken off the line for general cleaning inside and out. The plant has been designed for continuous operation. Mill repairs during the heating season consist only in changing the hammers. A set of hammers has been changed in 11 minutes from the time the turbine has been shut down to starting it up again. Major replacements are made in the summer.

The operation of this installation has been very satisfactory. The content of CO_2 in the flue gases varies from 12 to 16 per cent, and depends on the rate of working. With the high rates of working and high percentage of CO_2 there is a tendency for the ash to fuse, which should be expected with Illinois coal and the type of furnace used.

Table I gives the principal data of this installation.

Fig. 3 shows an application of powdered coal to two small Stirling boilers at the plant of Pejepscot Paper Company, Lisbon Falls, Me. The two boilers are set in a battery with brick air-cooled furnace walls and

bottoms. Storage system is used at this plant. Plant operates continuously six days a week and is shut down over Sunday. Table II gives the principal data of this plant.

Fig. 4 shows a powdered-coal application to one of the three Edge Moor horizontal water-tube boilers at the plant of Cushman Paper Company, Augusta, Me. At this plant the boilers are fired by the direct-firing pulverized-coal system. They are fired horizontally with one Couch burner to each boiler. One of the furnaces has fin-tube water-cooled side walls, whereas the other two have air-cooled hollow walls.

TABLE I

Installation—A. H. Budlong, Nursery, Chicago, Ill.
When installed—1925.
Number and size of boilers—Two horizontal return-boilers, 72 in. in diameter, 18 ft. long and containing 1830 sq. ft. of heating surface each.
Number and size of tubes—124 3-in. tubes.
Kind of setting—Brick, partly air-cooled side wall and bottom of furnace.
Method of firing—Direct firing pulverized coal.
Width of furnace—7 ft.
Height of furnace—Bottom of shell to bottom of furnace, 7 ft. 10½ in. rear, 8 ft. front.
Length of furnace—23 ft.
Kind of pulverizing mill—Two Raymond No. 3 impact mil's.
Capacity of each mill—1400 lb.
Method of driving mills—Steam turbine direct connected, 1800 rpm.
Number and type of burners—One 8-in. Leach burner per boiler, horizontal firing.
Load on boilers—Maximum winter load 12,000 lb. of steam per hour. Minimum load during warm weather, 2400 lb. of steam per hour intermittently.
Continuity of operation—Boilers on for three months at a time.
Approximate efficiency—78 to 80 per cent at 150 per cent of rating.
Coal used—Illinois No. 5 size.
Is installation satisfactory?—Yes, very.

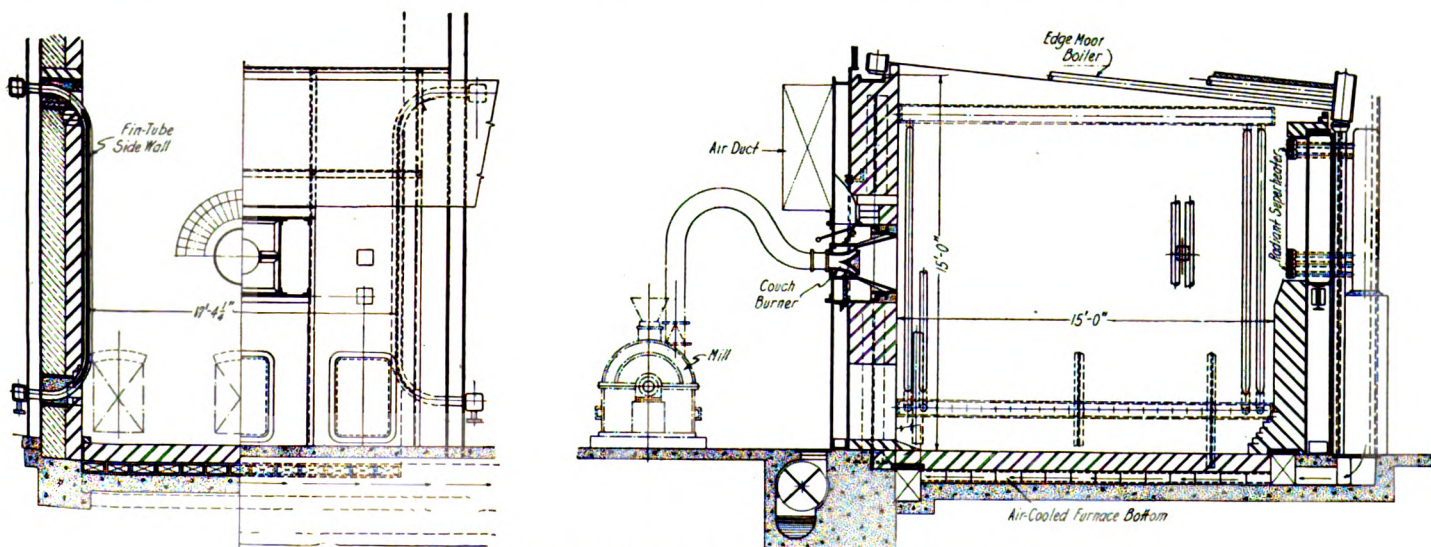


FIG. 4—Application of powdered coal to an Edge Moor boiler.

All three furnaces have air-cooled furnace bottoms and radiant superheaters in the rear wall. Table III gives the principal data of this installation.

Fig. 5 shows a two-drum Ladd boiler equipped with air heater and water-cooled fine-tube furnace at the plant of the Atlas Portland Cement Company, Northampton, Pa. It is fired with powdered coal by the direct-firing system, using vertical firing and Lopulco burners. The boiler is kept continually in service for a month. It is then taken off the line and thoroughly washed inside on account of bad feedwater. Table IV gives the principal data of this unit.

Fig. 6 shows a powdered-coal application to two B. & W. horizontal water-tube boilers. This installation uses the direct-firing system. Coal is fired horizontally with a Couch burner. Table V gives the principal data of this installation.

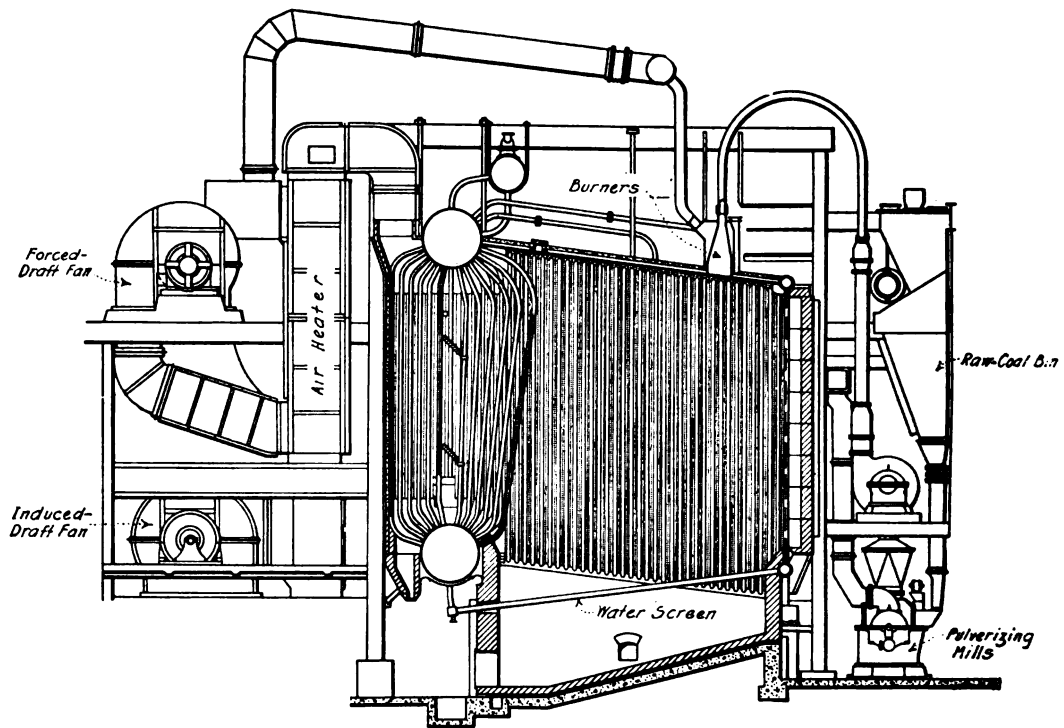


FIG. 5—Application of powdered coal to a Ladd boiler with water-cooled furnace.

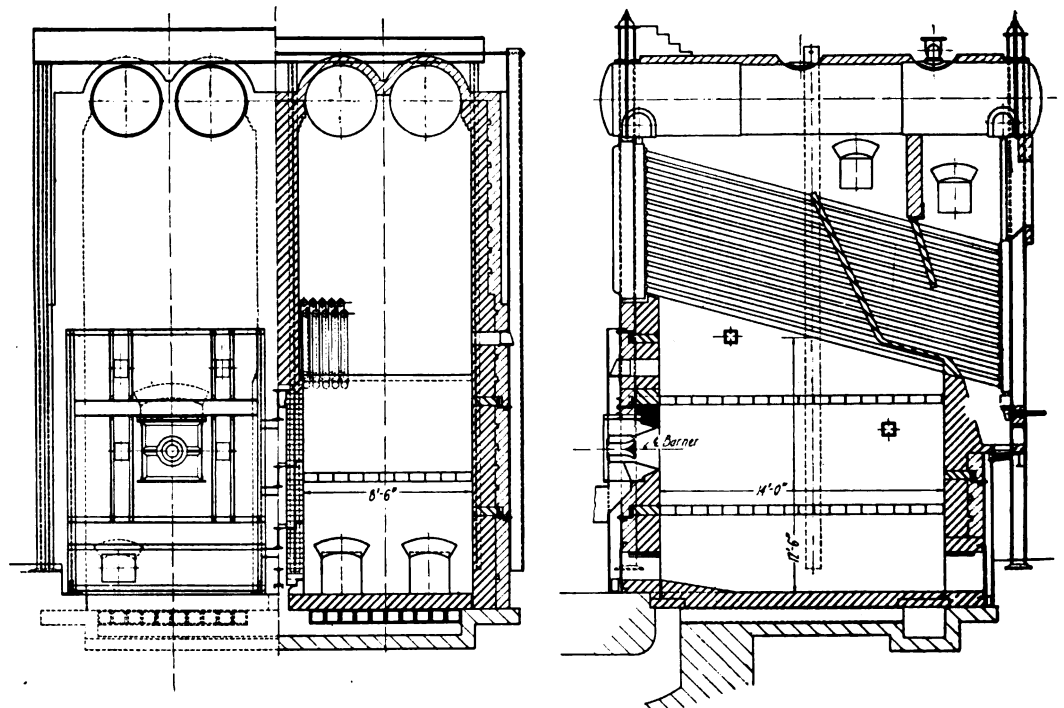


FIG. 6—Application of powdered coal to a Babcock & Wilcox boiler.

TABLE II

Installation — Pejepscot Paper Company, Lisbon Falls, Me.
Object of plant — Steam for power and process.
When installed—1924.
Boilers — Two Stirling; 3,750 sq. ft. of heating surface each; brick furnace with air-cooled hollow walls and water screen over the furnace bottom.
Furnaces—2,170 cu. ft. of furnace volume; vertically fired; storage system.
Burners—Two Lopulco burners to each boiler.
Rating—14,000 to 28,000 lb. steam per boiler per hour.
Service—Operates 24 hours, 6 days a week. Plant idle on Sundays.
Efficiency—80 to 81 per cent.
Coal used—New River.

TABLE III

Installation — Cushnoc Paper Company, Augusta, Me.
Object of plant—Steam for power and process.
When installed—1926.
Boilers—Three Edge Moor horizontal water-tube boilers, 6000 sq. ft. of heating surface each.
Furnaces—One furnace has water-cooled fin-tube side walls, and a radiant superheater in the rear wall. The other two have air-cooled hollow walls with radiant superheater in the rear wall; furnace volume, 2800 cu. ft.; all three furnaces are direct fired.
Burners—One Couch burner firing horizontally to each boiler.
Load—30,000 to 36,000 lb. of steam per hour per boiler.
Service condition—24 hours per day for 6 days a week—plant shut down Sundays.
Efficiency—78 per cent.
Coal used—Pocahontas slack.

TABLE IV

Installation — Atlas Portland Cement Company, Northampton, Pa.
Object of plant—Steam for power for manufacturing cement.
When installed—1926.
Type of boiler—One 2-drum Ladd boiler; boiler heating surface 7200 sq. ft.
Type of furnace—Water-cooled fine-tube side walls and roof. Water-cooled tubes and refractory front wall; water screen over bottom of furnace; water-cooled furnace surface, 2,150 sq. ft.
Air heater—24,480 sq. ft. heating surface.
Width of furnace—24 ft. 6 in.

(Continued on page 596)

Air Preheating and Stage Feed Heating*

A Simple Explanation of the Reasons for, and Economies to be Derived by Preheating Air and Extracting Steam from Turbines—Efficiencies Enumerated

By S. C. MILLER†

THE preheating of the combustion air for steam boiler furnaces, which has been extensively adopted in marine practice for over 30 years, has, within the last two or three years, been applied to a very considerable number of land installations. The

admitted to the less expensive earlier stages. In turbines for high pressures, it pays to heat progressively the boiler feed-water by steam extracted from a series of stages of increasing temperature and pressure, until the thermal advantages obtainable are neutralized by the increased cost of the necessary heaters, and the cost of additions to the throttle end of the turbine neutralize the gain in the exhaust end and condenser. Fig. 1 is a chart (for which we are indebted to Mechanical Engineering) to indicate the possibilities of this system.

It is obvious that if full advantage be taken of this method of Btu. conservation, the "economizer" which heats the feed water by heat exchange from the flue gases is left minus a job. The best method yet found to utilize the heat formerly recovered by the "economizer," is to transfer it by means of a "preheater" to the air for combustion. Probably owing to the demand created by this method of improving the heat balance, new and improved types of preheaters have been introduced and it is claimed that as much as 70 per cent of the waste heat in the flue gases can be recovered. In addition it is found that improved combustion follows, and a further economy than that due to the recovery of heat alone is obtained. Fig. 2 is a diagrammatic representation of the increase of thermal efficiency following the application of the preheater to a boiler. 13.125 per cent of the heat in the fuel is recovered and reintroduced with

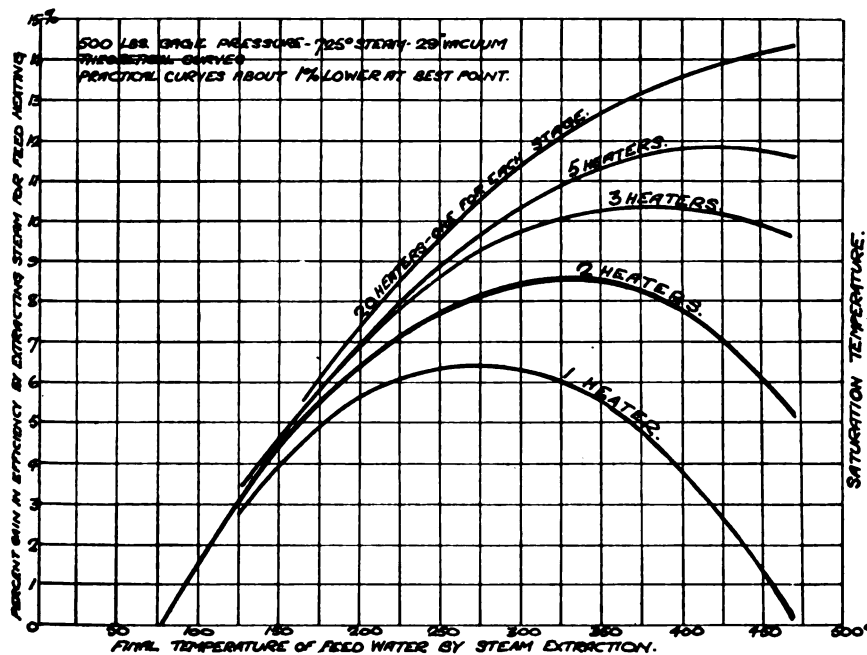


FIG. 1—Theoretical gain obtained by stage bleeding.

reason for this is to be found principally in the increased recognition of the economic advantages of the stage extraction or "bleeder" system of feed heating. This latter principle is likewise one which marine engineers had for many years been accustomed to utilize, usually in heating the condensate by means of steam extracted from the steam chest of the intermediate or low pressure cylinders of the engine.

The increase in thermal efficiency is easily understood because when the steam has been expanded down to the final steam chest pressure of a multiple expansion engine or to the later stages of a turbine, it has lost nearly all its "kick," but only a relatively small proportion of its heat. It pays, therefore to exchange as much of that heat as possible to the condensate and thereby return it to the boiler. The expensive low-pressure stages, and condenser, can be reduced in size and the energy which the extracted steam would have supplied can be replaced by additional steam

*Powerfax.

†Elliott Company, Ridgway Dynamo and Engine Works, Ridgway, Pa.

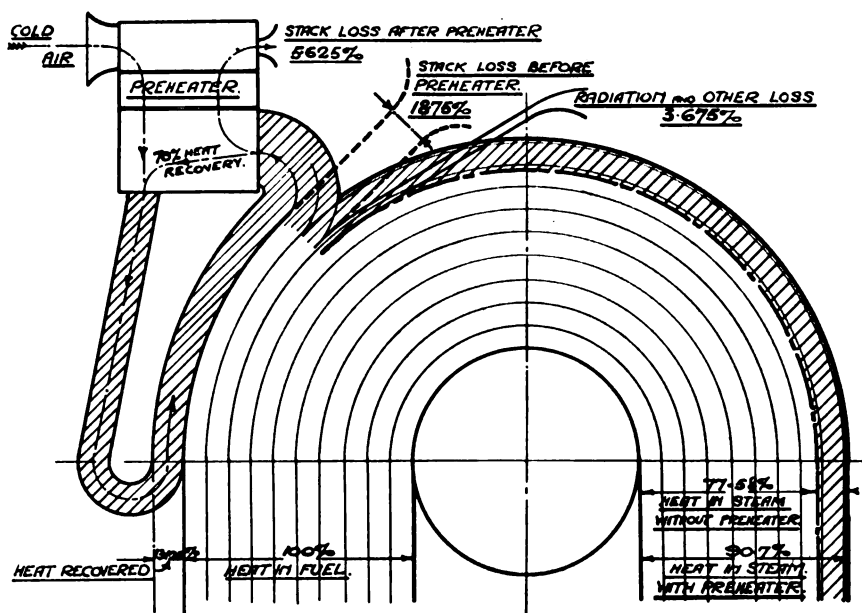


FIG. 2—Diagram showing increased thermal efficiency due to use of preheater.

the combustion air to the boiler furnaces, whereby the boiler efficiency is raised from 77.58 to 90.7 per cent.

An additional consideration which has influenced the installation of "bleeder" heaters in preference to economizers is that, owing to the gradual increase in boiler pressures, additional strength must be provided or complications introduced into the feed pumping system so that low pressure water is contained therein. The "bleeder" heaters necessary to replace the economizer cost a very small proportion of the cost of the latter, and have the advantage of being small and conveniently installed alongside the feed pumps. Further, having steam on one side and distilled water on the other they are not liable to become foul or corroded as is the economizer, which is exposed to the action of dirty and corrosive flue gases.

The preheater, of course, is exposed to the flue gases as is the economizer, but as no pressure is contained within the former, no danger is engendered. In the modern types of preheater, moreover, the surfaces are very readily kept free of deposit or corrosion and as the heat is not transmitted through the plates, corrosion has little effect on the efficiency of heat transfer.

Up to the time of writing, the installation of this combination of heat savers has been confined mainly to the larger power plants and industrial establishments, but it is certain to attract favorable attention from engineers and owners of smaller units as the price of fuel continues upward. It is similarly possible by means of this combination or of the preheater alone, in many instances, to increase greatly the steaming capacity of existing boilers.

Coke Statistics for October

The out-put of by-product coke for the month of October amounted to 3,713,000 net tons, an increase of 111,000 tons, or 3.1 per cent, when compared with the September production. This total has been exceeded but twice during 1927, in March and May, and with the exception of October, 1926, is the highest yet recorded for October. The daily rate for the 31 working days was 119,774 tons, slightly less than the rate of 120,067 tons for the 30 days in September.

Powdered Coal Applied to Small Boilers

(Continued from page 594)

Length of furnace—Front to rear, 20 ft.
Height of furnace—Roof to water screen, 20 ft.
Method of firing—Direct firing, vertically downward.
Number and type of burners—Eight Lopulco burners
Kind of pulverizing mills—Two No. 70 Raymond impact mills.
Load on boiler—60,000 to 140,000 lb. of steam per hour.
Coal used—Pennsylvania high-volatile bituminous coal.
Approximate efficiency—81 per cent operating efficiency by the month.

TABLE V

Installation—American Writing Paper Company, Holyoke, Mass.
Object of plant—Steam for power and process.
When installed—1926.
Boilers—Two B. & W. horizontally fired water-tube boilers, 4000 sq. ft. of heating surface each.
Furnaces—Solid brick-wall furnace—volume, 1386 cu. ft.; direct fired; horizontal burners.
Burner—One Couch burner to each boiler.
Load—24,000 lb. steam per hour.
Efficiency—76 per cent.
Coal used—Pocahontas.

Synchronous Motors for Driving Mills

(Continued from page 590)

one 600 hp., 400 rpm.; one 600 hp., 514 rpm.; and one 600 hp., 900 rpm. to drive various merchant and rod mill stands.

Two 400-hp., 720-rpm., 60-cycle, 4,600-volt motors have been purchased by the Higgins Brass & Manufacturing Company, Detroit, Mich., to drive brass and copper mills.

Another manufacturer has built several synchronous motors for seamless tube mill service, some of them being for piercing mills and some for tube rolling mill drives.

Field of Application

The field of application of the synchronous motor in main roll service is limited to strictly constant speed drives. This eliminates it from consideration on reversing mills, mills requiring flywheels, and mills needing adjustable speed.

It is not as a rule advisable to attempt to apply it to any type of mill which may have to be started with metal in the rolls, such as a cold strip mill, nor to cold sheet mills, which have excessively high friction. Such mills may require at starting considerably more torque than is needed to carry their full load at full speed, and unless the motor is sufficiently small in comparison to the power system so that it can be started at full voltage, difficulty may be experienced in getting started and synchronized.

In connection with constant speed continuous mills of the type shown in Fig. 3, looping mills as illustrated in Fig. 2, and in fact, almost any constant speed hot metal mill, the synchronous motor deserves very careful consideration. Every individual case must be studied very thoroughly to make certain that no misapplications are made. Careful thought must be given not only to the full load rating required, but also to the maximum torque that may be necessary to break the mill from rest under the most adverse conditions; to the maximum torque needed at pull-in; to the torque required to back out cobbles; to the maximum peak load that may be encountered; to the kv-a. demand that the power system can stand, without disturbance, while starting the motor; and last, but not least, to the characteristics that can be obtained in the motor, to determine whether it can meet the requirements.

Conclusion

The foregoing discussion, we believe, has made clear that the synchronous motor is a real competitor of the wound rotor induction motor for some types of main roll service. The number of installations which have been made within a comparatively short space of time certainly proves this contention. The synchronous motor has certain definite advantages such as better power factor, efficiencies and cost, which make it very attractive. Its starting characteristics are not so good as those of the induction motor, but for many drives they are sufficient, and on those mills it can often be used to advantage.

It seems safe to predict the widely increasing use of the synchronous motor in mill service, and with this prediction goes the hope that such motors will be applied, designed and built only with a full knowledge of the demands of the load and the limitations of the motor.

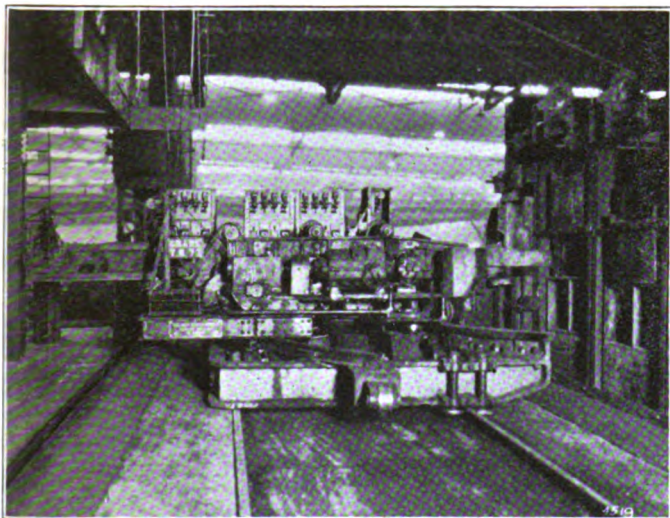
WITH THE EQUIPMENT MANUFACTURERS

A New Labor Saving Machine

The recent impetus given in this country to the manufacture of seamless steel tubes of the larger sizes has necessitated the production of special machines to meet the peculiar and severe operating conditions, as well as to lighten the burden of hand labor.

In the manufacture of seamless tubes on pilger mills tapered round ingots of a diameter approximately 50 per cent larger than the finished product are generally used. These are heated, preliminary to the piercing process, in a continuous heating furnace having a long inclined hearth. The taper on these ingots prevents their rolling down the inclined hearth in a line parallel to the walls, the path being rather in the arc of a large circle.

To overcome this difficulty it has been customary to provide the side walls of the furnace with a series of doors or poke holes spaced 3 or 4 ft. centers through which bars were inserted and the ingots straightened on the hearth and rolled down toward the discharge end. This was all done by hand labor. The extreme heat as well as the size of ingots required for large tubes made it difficult to maintain a suitable force of men, and the operation was slow and in general unsatisfactory.



In line with its progressive policy, and its past record for devising labor saving machinery, The Wellman-Seaver-Morgan Company, Cleveland, Ohio, has recently developed and put into successful operation two fully mechanically operated "barring" or ingot turning machines for eliminating the strenuous hand labor described.

These machines are typically American, being of "steel mill" design, i.e., they are extremely rugged and of all cast steel construction. Traveling on an inclined track parallel with the furnaces, and having the same slope as the furnace hearth, they perform all the functions previously done by hand with greater speed and ease, and in addition eliminate from six to eight men from the force required to handle each furnace.

Each consists of two distinct carriages. The lower one is a massive one-piece steel casting mounted on four wheels, engaging the main inclined track. These wheels are driven in pairs by two motors. On the upper surface of the lower carriage is carried a section of circular track, the center or radius point being at a point located at the center of the furnace wall. The upper carriage travels on this curved track and carries a long wedge shaped bar which can be moved in and out of the furnace, swing about the radius point above mentioned, rocked vertically and also turned about a horizontal axis. Each motion is operated by an independent motor and all are under direct control of the operator who is located at the rear and to one side of the center of the upper carriage.

The location of the pivot point of the bar when swinging in a horizontal plane is such that the extreme angularity may be obtained regardless of its position in relation to the furnace.

To facilitate the changing of bars, a quickly detachable connection is provided between the bar and its supporting spindle.

Electric current is brought to the machine by means of an underground conduit, maintaining a clear space overhead.

Three of the larger ingots may be straightened on the hearth or rolled down its inclined surface at one time by each machine.

In case ingots become partially welded together they may be "sliced" or separated by the bar, due to its shape.

The majority of the drives are of the worm type. The worm reductions as well as all spur gear reductions operate in oil baths contained in cast steel housings.

Due to governing clearances, these machines are very compact, yet all parts are readily accessible for inspection or repair.

The salient features of construction are protected by pending United States patents.

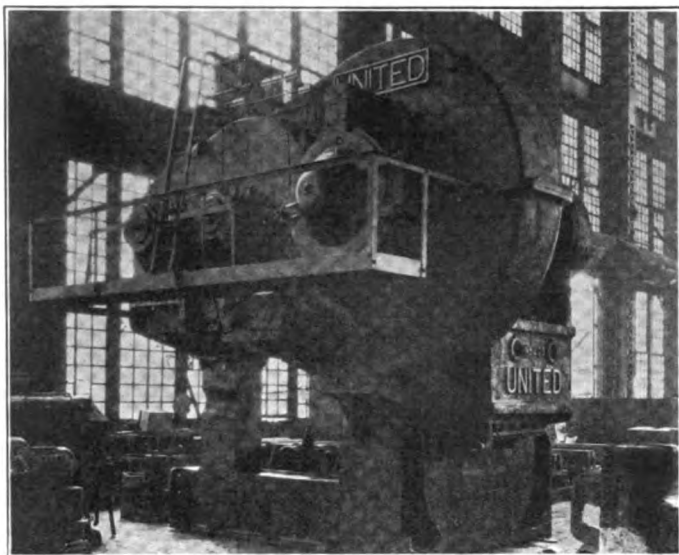
New Bloom Shear

This shear has a capacity of 5,500,000 lbs. between the knives and is designed to cut 3 in. x 36 in. or 5 in. x 22 in. cold steel bars. Its stroke is $6\frac{3}{4}$ in. and it runs at 12 cuts per minute. It has an overall height of 20 ft. and is driven by a 250 hp. electric motor. It is all steel in construction, except the bearings and liners, which are of bronze. The weight of the main housing is 125,000 lbs. The ram is balanced at all points by a patented compensating spring balance. All gears are cast steel with double helical cut teeth. There is an oil gag on the entering side of the shear and all moving parts are lubricated by a circulating oil system from one central point.

An auxiliary piece of machinery in connection with this shear is a special pusher for feeding short pieces and getting rid of crop ends. This pusher delivers the crop ends to an adjustable chute.

The shear can be operated from a distant point by means of a motor driven pull out device for the clutch pin. This clutch is of the patented non-knocking type with a positive pull out and definite jaw clearance when out.

A motor operated gauge is also part of the equipment for this particular shear.



The illustration is a side view and shows up the gear case behind the platform very prominently, from which an idea of the size of the gear drive may be gained. The sight feed manifolds for the oiling system also show very clearly, giving some idea of the ease with which the flow of oil may be controlled to any desired point.

It will be observed that this shear is on the four post order, occupying a minimum of floor space for its size. The shear is a product of the United Engineering & Foundry Company.

Continuous Automatic Shearing Machine

Substantial reduction in labor cost and increased production are made possible in sheet and tin plate mills by means of a continuous, automatic shearing machine recently placed on the market by the Streine Tool & Mfg. Company, New Bremen, Ohio. In a tin plate mill this machine, requiring only two operators, is capable of handling seven or eight packs a minute, or approximately 10 tons an hour. It is estimated that it will do the work of eight or more shears, a saving of about 14 men thereby being effected.

Tin packs are fed lengthwise, curl end first, into a caterpillar conveyor; this conveyor forms an integral part of the machine, and transports the pack into the side cutting shears. When the pack reaches the proper position, the conveyor automatically stops and the shears automatically trim both sides of the pack to any desired width, whereupon the conveyor again starts, carrying the pack to the end cutting shears. The end cutting shears have an electric switch located on the shear bed which controls the cutting off of the curl or front end. This switch is adjustable so as to provide for cutting off any amount ranging from $\frac{1}{2}$ in. to several inches.

After the curl end is cut off, this switch remains disengaged while the pack passes onto the back gage,

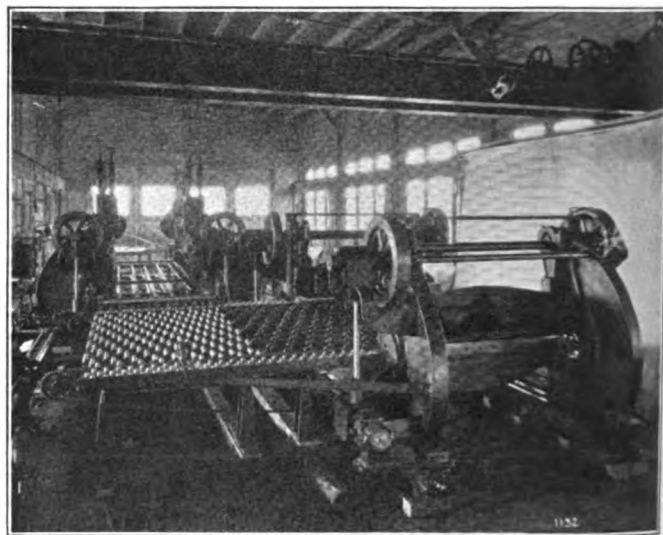
which is adjustable for lengths of from 12 in. to 30 in. or any other length desired. Here an electric switch stops the conveyor, causing the end cutting shear to cut off any sized multiples desired. This operation is repeated until the entire pack has passed through.

While this pack is in the process of being cut into the desired sizes another pack is entered into the side cutting shears, thus making for continuous, automatic shearing.

Adjustment of the side cutting shears is made by means of a reversible speed motor, which moves one of the shears back and forth, this movement being recorded on a large clock-type indicator. The indicator has an inch hand and a fraction hand, and is easily read. This enables the operator to adjust the shears to within less than $\frac{1}{64}$ in. The end-cutting shears are adjusted for various lengths by means of a graduated, crank operated back gage. Both the side and the end shears can be adjusted for width and length in less than one minute.

Consisting of a pair of upper and a pair of lower chains equipped with special pressure pads, the caterpillar conveyor is an important part of the machine. It exerts a powerful pressure which flattens out the pack so that when the two side cutting shears trim the edges, the distance across the pack is the same from one end to the other. This process is especially useful in view of the fact that tin plate packs coming off the hot mill are usually bowed or dished and therefore do not lie flat.

Since the pack is held not only by the conveyor, but also by the two hold-downs, and since the two shears cut in the same general direction, straight and parallel sides are assured. The shears are mechanically counterbalanced, no counter weights being used



at any point. The clutches are solenoid operated, and the eccentric shafts are supported with heavy bearings, including an outboard bearing which prevents deflection due to operation of the clutch.

The continuous automatic shears can be arranged for three purposes; for cutting packs of tinplate into multiples; for cutting packs of sheets; and for cutting flat sheets and plates of ferrous or non-ferrous metal.

Sheet packs which are of the same general shape and have about the same properties as tinplate packs are sheared in the same manner except that the shears are much larger and heavier in construction.

In this case the side cutting shears are 168 in. long and have capacity for cutting $\frac{3}{8}$ -in. steel. They are adjustable for cutting from 18 in. to 48 in. wide or even wider if desired. These shears cut the sheets perfectly parallel, straight and without camber.

The end cutting shears are also similar to those used for cutting tin plate, but are correspondingly wider and are so arranged that sheets ranging in length from 3 ft. to 12 ft. or more can be cut.

It is estimated that in the ordinary sheet mill the machine will care for the output of six mills. Three operators are required and the expense of about 10 men is eliminated. The capacity depends upon the length of the sheets and ranges from six to ten per minute.

The construction of the machine used for shearing non-ferrous sheets such as zinc, copper, brass, etc., differs somewhat from that adapted for sheet and tin plate practice. Instead of passing between two conveyors having pressure pads, the pack moves on the top of a roller conveyor to the side shears. After the sides are trimmed, it moves on to the finishing table, which carries it at right angles to the conveyor, to the end cutting shears.

These non-ferrous sheet shears can be built for shearing widths ranging from 9 in. to 66 in. and lengths from 3 ft. to 12 ft. and the entire equipment is especially guarded to prevent any scratching or marring of these comparatively soft sheets.

This four shear equipment is also suitable for use in jobbing mills and in light plate mills where the material is rolled in single sheets or in pairs and is roller-leveled before being sheared.

While the principal object in the design of these machines is to provide for more accuracy and reliability in the quality of shearing it is also notable that a very great saving in the cost of operation is accomplished.

High Pressure Fluid Generator

A piece of apparatus of novel construction is the Hypressure Jenny placed on the market by the Homestead Valve Manufacturing Company of Homestead, Pa.

It is composed of a boiler formed of several coils of tubing through which water, or some other fluid, circulates, and in circulating becomes heated to a point such that it forms a spray when released. The boiler is heated by a liquid, or gaseous fuel, supplied by a pump operating in unison with a second pump through which passes the fluid to be heated. The movement of the first pump is so controlled that it supplies fuel in correct proportions to the quantity of fluid flowing through the tubes. A pressure of 150 lbs. can be generated in 35 seconds by the throw of a switch. By appropriate mechanism the pumps are stopped whenever the desired pressure has been attained, but there is no diaphragm or thermostat control necessary. A motor drives the machine.

In service the Hypressure Jenny is of use for cleaning grease or grime from any surface, for sterilizing containers, for thawing frozen pipes, etc., for removing the dirt from roll housings and for taking paint off of metal. It may in fact be employed for any purpose where a high pressure fluid is demanded. As the assembled equipment is portable it can be carried to any place.

Welding Strong as Riveting

That welded joints in structural members may be produced having holding values equivalent to those of riveted joints is demonstrated by a series of tests recently conducted by the General Electric Company. Test specimens were made by the General Electric Company, using the metallic arc welding process, and the actual testing of specimens was made under the direction of Professor T. R. Lawson of the Rensselaer Polytechnic Institute, in the laboratory of that institution.

These tests were made on $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in. fillet welds, this type of weld being commonly used in fabricating machine parts and steel structures from standard rolled steel shapes. On each size of fillet there were made tension and compression tests, fillet lengths being $\frac{1}{2}$, 1, 2, 3, 4, 5 and 6 in.

A summary of the results of the tests shows that a $\frac{1}{4}$ -in. fillet will stand a safe allowable load of 2600 lb. per lineal inch, using four as a factor of safety. Corresponding values for $\frac{5}{16}$ and $\frac{3}{8}$ -in. fillets are 2900 and 3200 lb. According to William Dalton of the General Electric Company a $\frac{3}{4}$ -in. rivet will stand a shearing load of 4500 lb. per lineal inch. Based on the results of the recent tests, a $\frac{3}{8}$ -in. fillet will sustain approximately the same load if deposited for a length of $1\frac{1}{2}$ in.

In summarizing the results of the fillet weld tests care was taken to use values representing the lowest average of test results on a number of fillets of the same size and length. This is important in view of the fact that, in many machine parts, members may be subjected alternately to tension and compression, and to vibratory stresses.

The welds tested were all made by hand and were made in one layer: that is, the entire fillet was built up in a single pass along the joint.

Electric Cable with Core of Oil

A new electric underground cable that has a core filled with oil for its entire length and which operates at twice the voltage of present underground cables, was discussed at the second day's session—November 29—of the regional meeting of the Great Lakes district sub-division of the American Institute of Electrical Engineers.

The cable, which has aroused keen interest among engineers and cable manufacturers throughout the world, was first installed in the United States during the past summer—12 miles being owned by The New York Edison-United Companies' system and six miles by the Commonwealth Edison Company of Chicago. These are the only commercial installations of this cable in the world. In the cables now generally in use the copper wires form a solid core, surrounded by oil-impregnated paper, which is enclosed in a lead sheath. The new cable, instead of being solid, has its wires stranded about a copper spiral, which forms a hollow the entire length of the cable. This central hollow or core is completely filled with oil under constant pressure.

Philip Torchio, vice president in charge of electrical engineering, of The New York Edison Company, in a paper dealing with the economic and commercial aspects of the new cable, said that "the new 132,000 single-conductor, lead covered cable, doubles at a single step the operating voltage of any underground cable of the past."

TRADE NOTES

The National Tube Company has placed a contract with the Chapman-Stein Furnace Company of Mt. Vernon, Ohio, for a recuperative tube reheating furnace to be built at their Lorain works. The furnace will be 40 ft. long, 13 ft. wide, outside of brick work and will have a capacity of 45 tons per hour. It will be built to handle pipe from 5 to 11 in. in diameter and 32 ft. long.

* * *

The Falk Corporation announces that arrangements have been made with William Kennedy & Sons, Ltd., Owen Sound, Ontario, whereby this company is to manufacture and sell Falk Continuous Tooth Herringbone Gears, Falk Herringbone Speed Reducers and Falk Flexible Couplings in Canada.

For 60 years, William Kennedy & Sons, Ltd., has been well known throughout Canada as founders and engineers. The broad experience of this concern and the splendid service it has rendered Canadian industries in the solving of technical problems, as applied to power transmission, has led The Falk Corporation to deviate from a long established policy and license William Kennedy & Sons, Ltd. to engage in manufacture under Falk patents and on Falk gear cutting machines.

This opens up to Canadian industry better methods of power transmission and brings the same advantages that United States industries have experienced in the remarkable efficiency of Falk gears, speed reducers and couplings.

* * *

Arthur G. McKee & Company, engineers and contractors of Cleveland, Ohio, have been awarded contract for redesigning and rebuilding the Norton Iron Works blast furnace at Ashland, Ky.

The stack will be converted from a hand filled to a skip-filled furnace, and will be provided with new top structure, McKee revolving distributor, coke handling equipment, etc.

* * *

The Morse Chain Company announces the appointment of Mr. Harry E. Matthews, as manager of their Charlotte, N. C. office. The managership in the Charlotte office became vacant with the death of Mr. George W. Pritchett, which occurred September 15. Mr. Pritchett had been manager of the Charlotte office since its opening and was well known throughout the south.

Mr. Matthews has been assistant manager of the Charlotte office for the last eight years or more. He is, therefore, well equipped to take over the responsibility of this office.

* * *

The Surface Combustion Company, one of the largest designers, manufacturers and builders of furnaces and equipment for the utilization of heat in industrial processes in the world has moved from New York to Toledo, Ohio, where it has maintained a factory for some years past. In order to take care of its expanding business the company is building a new factory in Toledo and a new office building for its

business force, engineering staff, research department and laboratory.

This company now maintains executive office in Wall Street, New York, business, sales, engineering and research departments in Toledo and branch sales offices in six other cities. A new branch sales office has also been established in New York at 117 Liberty Street. Mr. Charles A. Blesch, formerly of the Pittsburgh office, has been transferred as manager of the New York office. The Toledo address of the company is 1375 Dorr Street.

* * *

The George J. Hagan Company have received a contract from the F.I.A.T. Company of Torino, Italy, for a number of electric furnaces for the heat treatment of automobile parts.

The contract covers one four-chamber counterflow pusher type carburizing furnace, three rotary hearth furnaces and one four-chamber car type furnace. The equipment will have a total connected load of 1,500 kw.

The transaction was handled by Mr. A. D. Dauch of the George J. Hagan Company through Deutsch-Amerikanische Elektroöfen of Berlin, Germany.

* * *

The Acklin Stamping Company of Toledo, Ohio, has opened a Detroit sales office at 3-239 General Motors Building. This office will be in charge of Mr. Harold Jay, as district manager, and all of their interests in Michigan will be handled from that point.

Mr. Jay has had eight years experience in their office in sales work and is thoroughly acquainted with all modern stamping methods and practices.

* * *

The Steel Frame House Company, a subsidiary of McClintic-Marshall Company, has been formed to take over the interests of the Broderick Steel Frame Corporation. The new organization will fabricate and furnish steel for homes and buildings.

* * *

Application for space at the American Foundrymen Association exhibition at Philadelphia, next May 14-18 is now acceptable. Applications may be made to Mr. C. E. Hoyt, secretary, Marquette Building, Chicago.

* * *

A cheering note in industry is the report of the Chapman Valve Mfg. Company, Indian Orchard, Mass., that it is running several departments overtime and has orders booked for the next 60 days.

* * *

The John J. Brice Foundry Company has been bought by Shepard Eleveator Company. Their properties are adjoining and as the latter concern is a great user of castings the combine is a saving move.

* * *

The steel club of Philadelphia met recently and elected the following officers for the year 1927-1928. President, J. B. DeWolf, Trumbull Steel Company; vice president, W. S. Haring, Alan Wood Iron & Steel Company. Directors, L. M. Schrufer, Lorain Steel Company; P. M. King, Worth Steel Company, and secretary-treasurer, F. J. Krause, Bethlehem Steel Company.

NEWS OF THE PLANTS

Mr. F. H. Willcox, vice president of Freyn Engineering Company has just returned from a three months' absence in Europe. During this period he visited Belgium, France, Germany, Luxembourg and England. The trip was taken in connection with three contracts which the Freyn Engineering Company is now executing, inclusive of the remodeling of Dudelage blast furnace plant at the Acieries Reunies de Burbach Eich Dudelage, Luxembourg, and the reconstruction of two furnaces at the Mannesmann Tube Works, Huckingen, on the lower Rhine. During his visit in Europe Mr. Willcox also made a study of methods there extant for the conditioning of blast furnace gas and the use of blast furnace gas alone or in mixtures for coke oven, open hearth and heating furnace applications.

* * *

The organization of the Hartford Coke Company, Hartford, Conn., a subsidiary of the Koppers Company has been completed. The company is erecting a \$9,000,000 plant at New Haven. Hugh Smith, Pittsburgh, is president; A. McArthur, New Haven, secretary, and S. T. Brown, Pittsburgh, treasurer. The stockholders are Mr. Smith, Mr. McArthur, Joseph F. Berry, Hartford, Conn., and the Koppers Company.

* * *

The Mary furnace of the Reading Iron Company at Hokendauqua, Pa., has been temporarily banked. Shipments however will be made from either the Keystone furnace of the same company or from stock.

* * *

After several years of review the report of the Federal Trade Commission, concerning the Bethlehem Steel Company merger complaint is ready for presentation. Mr. J. W. Bennett has prepared the report.

* * *

The Bucyrus Erie Company announces the election of the following officers: W. W. Coleman, president; E. J. Swigert, senior vice president; G. A. Morison, vice president and treasurer; J. G. Miller, secretary. Mr. Coleman is also chairman of the board. This is the group which heads the combine of the Bucyrus Company and the Erie Steam Shovel Company.

* * *

The Alabama Power Company a subsidiary of the Southeastern Light & Power Company is planning to build a plant of 50,000 kw. capacity at Gorgas, Ala. As the demand for power increases units will be added to bring the capacity to 200,000 kw.

* * *

Norton Iron Works at Ashland, Ky., is redesigning its blast furnace from a hand filled stack to more modern skip hoist type. Arthur G. McKee & Company, Cleveland, is to do the redesigning and rebuilding.

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The new continuous tin mill of the American Sheet & Tin Plate Company, Gary, Ind., started operating on November 3. This mill represents another step in rolling processes in that it is a continuous black plate rolling mill.

ing processes in that it is a continuous black plate rolling mill.

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The following companies have merged to form the General Cable Corporation: Baltimore Copper Smelting & Rolling Company, Dudlo Manufacturing Corporation, Rome Wire Company, Safety Cable Company, and the Standard Underground Cable Corporation.

* * *

The Chicago Steel Tank Company has recently moved into the new plant at 6400 West Sixty-sixth Street, Chicago. This company manufactures tanks and does general steel plate work.

COMING MEETINGS

Dec. 5-8—Annual meeting, American Society of Mechanical Engineers, Engineering Society Building, New York City. Calvin Rice, secretary, 29 West Thirty-ninth Street, New York.

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Dec. 5-8—Sixth national exposition of Power and Mechanical Engineering, Grand Central Palace, New York City. Fred W. Payne, manager, Grand Central Palace.

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Dec. 6-8—American Refractories Institute. Hotel Chase, St. Louis, Mo. D. A. Texter, secretary, 2202 Oliver Building, Pittsburgh, Pa.

* * *

Dec. 6-8—American Institute of Chemical Engineers, St. Louis, Mo. H. D. Parmelee, secretary, Tenth Avenue and Thirty-sixth Street, New York City.

* * *

Dec. 8—American Institute of Weights and Measures. At the institute headquarters, 115 Broadway, New York City. W. E. Bullock, secretary.

* * *

Dec. 13-15—Third annual Conference on Welding, Purdue University, Lafayette, Ind. W. A. Knapp, professor in charge, Engineering Extension Department.

Traffic Club Dinner

The Traffic Club of Pittsburgh will hold its mid-year dinner on Thursday, December 15, at the William Penn Hotel. Mr. Gordon Fisher, president, Spang, Chalfant & Company, Inc., Pittsburgh, will deliver an address. As the Allegheny Regional Advisory Board holds its meeting at the William Penn Hotel on December 15, an invitation has been extended to Regional Advisory Board members to attend this dinner.



Mr. Edwin H. Lundgren, for the past four years general sales manager of the Combustion Engineering Corporation, has recently been elected vice president and general sales manager. Mr. Lundgren is well known in the power plant field, having been actively identified with the stoker business since 1912. His association with the Combustion Engineering Corporation began in 1921 at which time he resigned as vice president and chief engineer of the Frederick Engineering Company, Frederick, Md., to come to New York. Mr. Lundgren is a graduate of the Swedish



Government Technical College with a degree of Mechanical Engineer. He is an authority on the design and construction of stokers and the author of numerous technical articles.

* * *

Mr. L. E. L. Thomas has recently become identified with Freyn Engineering Company in the capacity of vice president, in charge of foreign business. Mr. Thomas has been active in the steel industry for many years. After a varied construction experience in the iron and steel industry, he was made chief draftsman of The Youngstown Sheet & Tube Company, Youngstown, Ohio.

In 1916 he became chief engineer of Gary Tube Company in connection with a plant to include docks, blast furnaces, steel making capacity, rolling mills and tube mills. With the suspension of that work, on account of war-time conditions, he was appointed chief engineer of United States Steel Corporation, ordnance department,

In 1920 he became chief engineer of Inland Steel Company, Indiana Harbor Works, holding that position until his resignation in 1927.

Jay G. Stephans, president of the Jay G. Stephans Corporation, announces the opening of an office in the Oliver Building, Pittsburgh, Pa. Mr. Stephans will center his activities on iron and steel scrap and allied products. He has been associated with this line of activity for the last 10 years, having formerly been with Hickman, Williams Company and Luria Brothers.

* * *

Mr. J. R. Edwards has been appointed manager of sales for the Erie City Iron Works, Erie, Pa., Mr. Edwards was formerly western sales manager for the Pittsburgh Steel Products Company. Before joining the Pittsburgh Steel Products Company in 1921 as special sales representative, he had been with the Reading Iron Company at Reading, Pa., and the A. M. Byers Company at Pittsburgh in sales capacities.

* * *

Mr. J. R. LeVally, who is special representative for the Erie City Iron Works, Erie, Pa., was graduated in mechanical engineering from Armour Institute of Technology in 1915. For two years he was chief operating engineer officer, U. S. Navy in charge of engine rooms of U.S.S. Vermont and later became chief engineer of U.S.S. Huron.

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Mr. C. O. Hoban, who has become special representative for the Erie City Iron Works, Erie, Pa., is a graduate of Carnegie Institute of Technology. He has done independent steel mill consulting work and for the past seven years has served as erector traveling engineer for the Riley Stoker Corporation. The last three years he has served as district manager of their Pittsburgh office.

* * *

Dr. W. D. Coolidge, assistant director of the research laboratory of the General Electric Company, has been awarded the Hughes medal by the Royal Society for "distinguished work on X-rays and the development of highly efficient apparatus for their production." The Hughes medal was first presented in 1913 to Dr. Alexander Graham Bell. Dr. Irving Langmuir, also of the General Electric research laboratory, received it in 1918.



Mr. Charles B. Francis has been appointed head of the Technical Bureau, Carnegie Steel Company to succeed the late J. M. Camp. Mr. Francis graduated from the University of West Virginia in 1906 and accepted the position of assistant chief chemist with the H. C. Frick Coke Company. Later he taught chemistry and physics and did consultant work until 1913 at which time he became associated with the Carnegie Steel Company as assistant chief chemist of the Clairton works. Since then he has been actively engaged in metallurgical research work. He is co-author with Mr. Camp of "Making, Shaping and Treating of Steel."

* * *

L. D. Bruekel has been appointed general sales manager of the strip steel division, Weirton Steel Company to succeed the late Henry C. Smith.

* * *

Richard Denens, formerly eastern manager of the Brown Hoisting Machinery Company, has become affiliated with the Link-Belt Company, Chicago in a similar capacity.

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R. P. Nick is in charge of motor and welder sales in the Lancaster district for the Lincoln Electric Company. He was formerly in the Baltimore, Md., office.

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J. F. Hunter has been appointed general safety inspector of Carnegie Steel Company to succeed Mr. Adam W. Slater, recently deceased. For the last 11 years Mr. Hunter has been engaged in similar work for the same company.

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Wm. L. Latta has been appointed chairman of the sheet steel simplification committee, as successor to W. C. Carroll. Mr. Latta is manager of sheet steel sales, Wheeling Steel Corporation.

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Mr. W. C. Halzworth has been elected president of the holding concern for the Struthers Furnace Company. The directors of the new company are E. G. Tillotson, H. W. Grant, Max Breitung, and J. H. Hillman.

Howard A. Poillon is now acting head of the Research Corporation, New York, to succeed Mr. A. H. Hamerschlag, former president who died recently.

Alonzo G. Kinyon Dead

Alonzo G. Kinyon, consulting engineer with the Fuller Lehigh Company, Fullerton, Pa., died on November 13 following an operation at Johns Hopkins Hospital, Baltimore, Md.

Born in Amboy, Ill., in 1870, Mr. Kinyon early became associated with railway work in various stages. During the time he was connected with the railways he was identified with development in the fuel burning equipment and fuel conservation with different railway companies. He also served as an instructor in railway equipment and operation with the International Correspondence School.

In 1915 Mr. Kinyon turned his attention to pulverized fuel, joining a company connected with the use of pulverized coal on locomotives, and he was so impressed with the possibilities that he resolved to make improvements in the use of pulverized coal his main interest. Later Mr. Kinyon organized the Kinyon Pulverized Fuel Engineering Company to work out pulverized fuel application for hotel and apartment use and in September, 1918 became associated with the Fuller Lehigh Company with which he continued until his death.

While his service to the various industries was marked by the contribution of valuable inventions in a wide variety of subjects, the outstanding point in Mr. Kinyon's career was the invention and development of the Fuller-Kinyon Conveying System for transporting pulverized material. This system is now widely in use in many diversified industries. In recognition of his efforts he was on November 11, 1926 awarded the Longstreth Medal by the Franklin Institute as well as life membership in that organization.

Besides his affiliation with the Franklin Institute, he was a member of the Traveling Engineers, International Railway Fuel Association, and American Society of Mechanical Engineers.

TRADE PUBLICATIONS

The General Electric Company of Schenectady, N. Y. has issued a paper called, "Centrifugal Air Compressors." It contains information regarding single stage centrifugal air compressors with particular emphasis laid upon applications and details of construction. There are also tables showing operating characteristics and ratings.

* * *

The quarterly report of the American Institute of Weights and Measures was recently distributed. This report covers new steps made in standardization together with numerous discussions pertaining to different proposed standards, and to their relations with one another. There is a copy of the institute constitution in the back of the book.

* * *

"Feed Water Heaters" is the title of a new booklet mailed by the Elliott Company, Jeannette, Pa. General information regarding the construction, adaptability, and all around usefulness of three kinds of heaters, namely: Open Feed Water Heaters, Deaerating Heaters and Closed Heaters, is discussed. The book is adequately illustrated with cuts and drawings.

* * *

The Combustion Engineering Corporation of New York has issued a pamphlet describing the Lauderdale plant of the Florida Power & Light Company. A short history of power development in the state of Florida coupled with descriptive matter concerning the building, installation, and equipment of the above plant constitute the text of the booklet.

* * *

"Homestead Valves" is the title of a new booklet compiled by the Homestead Valve Company, Homestead, Pa. This book serves not only as a general catalogue on this company's products, but as a handbook of general information to valve users as well. Prefacing the text is a short discussion on the use of valves in relation to the chemical with which they are to be used and the metals of which they are composed. For each general type of valve there is a short text describing its operation, principles and applications. These descriptions are followed by pages devoted to individual types, their price lists, and dimensions. Part of the catalogue is devoted to spare parts and their replacements and uses as well. In the back of the book is a page headed "Trade Customs," which covers ordering and shipping data.

* * *

The first publications to be issued by the recently organized Foster Wheeler Corporation are its bulletins numbered EC-102, 120 and 119.

The Foster Wheeler Corporation was formed through the consolidation of the Power Specialty Company and the Wheeler Condenser & Engineering Company, as announced a few months ago.

Bulletin 102 describes the Foster Economizer, now widely used in power plants in the United States, Canada, Great Britain and Continental Europe. The

new publications contain much interesting test data, photographs, drawings and a steam table up to 1,500 lb. gauge pressure and 300 deg. F. superheat.

Bulletin 120 covers the new extraction type feed water heaters usually installed in turbo-electric power stations. This bulletin includes heat balance diagrams and will be found of great assistance by steam plant designers.

Bulletin 119 deals with hot water heating systems of the forced circulation type employing exhaust steam from the power plant as the source of heat. The bulletin contains photographs taken in nationally known plants and will show power plant engineers exactly how this system applies to the modern power station and heating problem.

* * *

A completely revised edition of the NEMA Handbook of Supply Standards has just been issued by the National Electrical Manufacturers Association of New York City, according to D. H. Murphy, vice president in charge of the supply division.

This 230-page book, which is indexed and illustrated, contains standards endorsed by 189 manufacturers of the supply division on air circuit breakers, attachment plugs, fuses, cutout bases, knife and enclosed switches, lamp receptacles and sockets, laminated phenolic products, metal molding, non-metallic flexible conduit, outlet boxes, overhead trolley line materials, panelboard and distribution boards, signaling apparatus, and snap switches, with approximately 125 illustrations, diagrams of designs and methods, and numerous tables and curves.

These standards have been approved by the standards committee, the official body for the control of technical standardization within the association. "This handbook represents in printed form the experience and knowledge of practical and technical men, who have for years been most vitally concerned with the design, manufacture and installation of electrical supply equipment," says C. A. Bates, chairman of the standards committee, and chief engineer of the Bryant Electric Company.

Copies may be secured by addressing the National Electrical Manufacturers Association, 420 Lexington Avenue, New York City.

* * *

Modern electric and fuel furnaces of the car and car-and-roll type for the heat-treatment of metal are illustrated in Bulletin No. 285 soon to be distributed by the W. S. Rockwell Company.

This bulletin contains a technical description of different forms of car and car-and-roll type furnaces with an outline of the field of usefulness and limitations of the different designs.

* * *

Bulletin "L" describing synchronous motors, a recent publication of the Elliott Company, contains 16 pages and is printed in two colors. In addition to the descriptive text matter it contains numerous views showing the construction of Elliott synchronous motors and motors at work in the field. There is also on the latter pages a discussion of the use of synchronous motors for power factor correction. Copies of the bulletin may be had from Elliott Company's district offices, or the main works at Jeannette, Pa., or the Ridgway Dynamo & Engine Works at Ridgway, Pa.

THE STEEL PLANT BRICK MASON

A Section Devoted to Items of General Interest to Blast Furnace and Steel Plant Brick Masons

Laclede-Christy Adds New Unit

The Laclede-Christy Clay Products Company is completing arrangements for the purchase of the Stowe-Fuller Refractories Company of Cleveland, a firm manufacturing fire-resistant clay products.

A special stockholders' meeting will be held December 24 at the offices of the Laclede-Christy Company to ratify the purchase.

The Laclede-Christy Clay Products Company, a pioneer in refractory manufacture, was founded in 1844 and incorporated in June, 1917. It has an authorized capital of \$1,800,000 7 per cent preferred stock and \$2,000,000 in common stock.

Harbison-Walker Make Further Improvements

The letting of contracts for four direct-fired tunnel kilns has just been announced by the Harbison-Walker Refractories Company. Including steel and concrete buildings and necessary equipment, this involves an expenditure of approximately \$1,300,000.

All four of the new kilns will be identical in type and size, two to be built at the Templeton, Pa., plant and two at Clearfield, Pa. They will be used in burning fire clay brick only. Each kiln will be slightly over 444 ft. long and will have a daily capacity of 35,000 9-in. brick.

The new kilns have been designed by American Dressler Tunnel Kilns Inc. of Cleveland, Ohio, and will be erected by William Swindell & Brothers, Pittsburgh, Pa., an associate company. The Swindell firm, established 1850, are among the oldest furnace builders in America.

Bricklayers Quit A. F. and L. Building Department

Officers of the Bricklayers, Masons and Plasterers Union gave notice to the American Federation of Labor that their organization had decided to withdraw from further association with the federation's building trades department. The action does not constitute

withdrawal from the national federation itself, it was explained at the bricklayers' national headquarters here, but does mean that hereafter the bricklayers will conduct their affairs without regard to the building trades department.



Francis D. Bott has the task of supervising all masonry work at the Clairton Plant of the Carnegie Steel Company where he is superintendent of masons. The Clairton plant is one of the largest of those controlled by the Carnegie Steel Company.

American Refractories Institute Meeting

In conjunction with the American Institute of Chemical Engineers, the American Refractories Institute is holding its fall meeting on December 6 and 7 at the Hotel Chase, St. Louis, Mo. On Tuesday there will be a joint meeting of the two institutes, but on Wednesday separate meetings will be held. Both meetings are open to any persons desiring to attend whether members or non-members. At the Wednesday open forum session of the Refractories Institute Mr. M. C. Booze former senior fellow of the Refractories Fellowship will preside. The president of the American Institute of Chemical Engineers is Dr. E. R. Weidlein, director, Mellon Institute of Industrial Research, Pittsburgh, Pa., while the president of the American Institute of Institute is Mr. J. M. McKinley, vice president and general manager of the Crescent Refractories Company, Curwensville, Pa.

The program for the meeting on Tuesday, December 6, is as follows:

"Formal Opening," Dr. E. R. Weidlein, president American Institute of Chemical Engineers and director

of Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

"Opening Address," Mr. J. M. McKinley, president, American Refractories Institute and vice president and general manager, Crescent Refractories Company, Curwensville, Pa.

Motion picture entitled, "The Story of Fire Clay Refractories."

"The History and Status of the Refractories Industry," by Mr. J. D. Ramsay, president of the Elk Fire Brick Company, St. Marys, Pa.

"Problems in the Development and Technology of

Refractory Materials," by Stuart M. Phelps, director of research and tests, Refractories Fellowships, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

"A Laboratory Furnace for Testing Slag Resistance of Refractories," by Professor R. K. Hursh, University of Illinois, Urbana, Ill.

"German Laboratory Practice," Mr. A. P. Green, president, A. P. Green Fire Brick Company, Mexico, Mo.

"Some Special Refractories in the Experimental Stage," by Mr. Geo. A. Bole, Research Professor of Ceramic Engineering, Ohio State University, Columbus, Ohio.

"Developments in Burned Dolomite as a Stable Refractory," by Mr. M. E. Holmes, director, Clay Testing and Research Laboratories, Rolla, Mo., and Mr. Geo. A. Bole.

A symposium for the discussion of problems primarily of interest to the chemical industry. Papers will be presented by nationally prominent chemical engineers, who are considered authorities in their field.

For the open forum session on Wednesday the program as arranged is:

Symposium on Tunnel Kilns, their operation, advantages and disadvantages. Conducted by Mr. M. C. Booze, vice president, The Chas. Taylor Sons Company, Cincinnati, Ohio.

"Work of the Refractories Fellowship at Mellon Institute," by Mr. Stuart M. Phelps, director of research and tests, Refractories Fellowship, Mellon Institute, Pittsburgh, Pa.

Charts Showing Some Notes on Performance of Straight Tile," by Mr. J. M. McKinley, president American Refractories Institute; vice president and general manager, Crescent Refractories Company, Curwensville, Pa.

"Simplification of Malleable Furnace Refractories," report by joint committee on foundry refractories.

"Dry Grinding of Refractories," by Mr. J. M. Galaher, treasurer and works manager, Clearfield Machine Company, Clearfield, Pa.

"Burning Refractories with Stokers," by Massillon Refractories Company, Massillon, Ohio.

Open Forum

10-minute discussions.

What might be considered good average and medium amount of coal to burn 1,000 9 in. equivalents in several types of kilns?

By Geo. A. Bole, Research Professor of Ceramic Engineering, Ohio State University, Columbus, Ohio.

What are the benefits to be derived from using hot water in the tempering of clay mix instead of cold water?

By Mr. E. H. Van Schoick, works manager, Chicago Retort & Fire Brick Company, Ottawa, Ill.

What is the cause of convex surfaces on hand molded shapes and how may same be prevented?

By Mr. E. H. Van Schoick.

What is the best refractory for use with coals high in ash with 2 to 4 per cent iron content (Illinois coals)?

By Columbus Branch, Bureau of Standards.

What type of refractories are best suited for puddling furnaces?

By Mr. C. E. Bales, production manager, Ironton Fire Brick Company, Ironton, Ohio.

What are some practical methods for preventing the coarse particles of clay from separating from fine clay in storage bins?

By Mr. C. E. Bales.

Information concerning the meeting may be secured through the secretary's office, 2202 Oliver Building, Pittsburgh, Pa.

Notes on the Design of Fire Clay Shapes*

By E. H. Van Schoick†

Some progress has been made of late years in the standardization of the so-called standard shapes of fire brick. There are about 27 of these shapes, not including the circle brick, and they are all based on and are variations of the standard 9 in. straight, measuring 9 x 4½ x 2½ in. Since they are of standard size and shape, they are carried in stock by manufacturers and when used judiciously in construction work, will save much cutting of brick, thus making a better structure at lower cost.

There is a second class of shapes which is more or less standard, many items of which are carried in stock by manufacturers. The standardization of this class has not progressed as far as the first and there is room for further work along this line. In this class may be included several sizes of cupola blocks and cement kiln liners, a series of air furnace bung brick, open hearth checkers and the 13½ in. series which is based on the 13½ in. straight and corresponds roughly to the 9 in. series mentioned above.

After leaving these two classes, the uncharted wilderness of special shapes is entered, where size and shape are limited only by the physical limitations of the raw material and the bounds of the draftsman's imagination. The variety of special shapes is legion. They range in weight from a few ounces to many hundreds of pounds, and vary in form from simple rectangular blocks to designs which are so intricate that it is quite an accomplishment to read the blueprint on which they are shown. To limit the variety of special shapes in an attempt to standardize them, is not only impossible but undesirable. Every refractory structure of a new or novel type will require at least some new and original shapes. But, in the interests of better service and longer refractory life, closer co-operation between the designer of refractories and the manufacturer should be sought and attained.

Every designer of refractory shapes should be familiar with the processes used in their manufacture. He should visit a fire brick plant, preferably the one which is going to make his brick, and become acquainted with the methods used. He will be particularly interested in the way the moulds are made, and in the moulding, drying, and setting of intricate special shapes. He will find also that the acquaintanceship gained with the men in authority at the plant will be valuable and that there will be an interchange of ideas

*Abstracts from Bulletin No. 16 issued by American Refractories Institute.

†Member Research Advisory Committee. Works manager, Chicago Retort and Fire Brick Company.

concerning his own problems that cannot help but be mutually advantageous.

While there can be no standardization of specially designed refractory shapes, there are certain general rules which can be applied to their design, which will be of much assistance to the manufacturer and will also tend to give the consumer a more satisfactory product.

Probably the most important general rule is, that if there is a choice of two or more designs for any shape or set of shapes, the design which is best adapted for successful manufacture will be the one that will give the best service in use. This is entirely logical. If the shape has been so designed that it is difficult to construct a mould which can be filled properly, such defects as folds, sand cracks, or spongy corners may result; or the proportions of the shape may be such that severe differential strains are set up in the drying and cracks develop at points of weakness. Even if the shape is satisfactory as far as the moulding and drying are concerned, it still may not be possible to set it properly in the kiln, and warpage or burning checks will result. The extremely intricate or badly proportioned shape has thus been subjected to excessive strains or possible failure in any or all of the steps in its manufacture. If it does come through apparently sound and in good condition, it is again subjected to stresses in use which are very liable to attack it at the same points of weakness which caused trouble in the manufacture. It is almost certain then to fail more rapidly than would the alternative design which could have been manufactured more easily.

Under service conditions where resistance to spalling is important, small units give better service than larger ones. This is almost a corollary of the rule given above, although it is not usually of as much importance to the manufacturer as it is to the consumer. This rule is particularly applicable to the design of suspended arches, door arches, jambs and lintels, feed hole blocks, etc. The internal stresses set up in fire clay shapes by rapid thermal changes are roughly proportional to the size of the individual pieces and failure occurs more rapidly in larger blocks when other conditions are comparable.

Designers should give the manufacturer all the information which is available concerning the shape or shapes which are to be made. Assembly drawings should be furnished wherever possible showing the relative positions of the various shapes with respect to each other. In case a design consists of a number of intricate shapes, it is sometimes advisable to make one or two pieces of each shape and assemble them on the dry floor before attempting to turn out the complete job. Minor changes can then be made in the moulds, if necessary, and the job carried to completion with an assurance of more satisfactory results than could be obtained without this preliminary fitting. Mould makers, moulding foremen, and yard superintendents are interested in their work and take much pride in turning out shapes which can be accurately assembled. This preliminary assembling cannot be made, however, unless complete drawings are furnished.

Fire brick manufacturers make every effort to control the shrinkage of their various mixes so that the finished product will be of the dimensions specified. But since absolute accuracy is unattainable without grinding the finished shapes to size, certain variations have been agreed upon by both manufacturers and con-

sumers as being permissible. In order that the designer be sure to make proper allowances for these variations, the maximum and minimum as well as the mean size of all important dimensions should be shown on every drawing. It will happen at times, that in so dimensioning his drawing, the designer will discover that he will have trouble if the shape should come to the maximum size on certain dimensions; in which case, he can so indicate on the drawing by reducing the mean size, or, if this is inadvisable, by marking the dimension in question "minimum preferred." It is much the better practice, however, to avoid showing any dimension on the drawing, which, if adhered to by the finished tile, would cause troubles in laying up the work.

There is almost invariably one face or surface of a hand moulded fire clay shape which is not as regular and true to a plane surface as are the other faces. This is the surface which is the top or cut-off face when the tile is moulded, and it is subject to certain irregularities and bulges which can be overcome to a certain extent, but which cannot be entirely eliminated. Sometimes, owing to the shape of the tile, there is no choice as to which side must be the cut-off face, but in many cases the shape may be moulded in one of two or more different positions, and the rough face can be made the one where slight irregularities will cause little or no trouble in laying up the finished brick. It will be of great assistance to the maker, therefore, if the designer will indicate on his drawing which of the faces of his shapes it is most important to have plane and true. If it is essential that certain faces be exactly parallel, or that certain angles be exactly 90 deg., it should be so indicated. Mould makers are quite ingenious in working out ways to put the so called "bellied" sides where they will do the least harm, if they have the proper information with which to work.

Sharp corners on inside surfaces or sharp reentrant angles are not permissible. Unavoidable cracks will develop at such points during drying and be aggravated during burning. It is, therefore, necessary to fillet all such angles on the drawings, for if not so shown either the drawings will be returned for correction or the fillets will be added according to the best judgment of the manufacturer. The radii of the fillets should be as large as possible in every case.

Combustion Meeting

A combustion division meeting of the Association of Iron and Steel Electrical Engineers was held at the Engineers Club, Philadelphia, November 5, with Martin J. Conway, combustion engineer, of the Lukens Steel Company, as presiding officer. Waldemar Dyrsen, chief engineer, Furnace Equipment Department, Blaw-Knox Company, delivered a paper on "Metal Air Heaters for Industrial Furnaces" in which he pointed out the advantages to be gained from the use of metal recuperators. He described the various types of recuperators with special reference to their construction and manner of operation. The types mentioned were the Calco, the Duraloy, the Mantle and the Blaw-Knox regenerative.

A paper entitled "Combustion Control for Industrial Furnaces" was read by F. J. Ryan, president of F. J. Ryan & Company. Mr. Ryan stated that the first company to adopt combustion and temperature control was the United States Cast Iron Pipe & Foundry Company.

SAFETY FIRST IN THE STEEL PLANT

Section Devoted to the Interest of the Safety Movement

Officers of Metals Section, National Safety Council

Chairman, J. A. Northwood, Bethlehem Steel Company, Johnstown, Pa.

Vice-chairman, E. G. Quesnel, Commonwealth Steel Company, Granite City, Ill.

Secretary and news-letter editor, John P. Eib, Illinois Steel Company, Joliet, Ill.

Chairman program committee, E. F. Blank, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

Chairman poster committee, C. L. Peake, American Radiator Company, Buffalo, N. Y.

Chairman membership committee, W. E. Megraw, H. H. Robertson Company, Ambridge, Pa.

Chairman publicity committee, J. A. Voss, Central Alloy Steel Corporation, Massillon, Ohio.

Chairman slide committee, John A. Oartel, Carnegie Steel Company, Pittsburgh, Pa.

Engineering representative, W. H. Winans, Union Carbide Company, New York City.

Chairman statistics committee, H. G. Hensel, The Youngstown Sheet & Tube Company, Chicago, Ill.

Executive committee: The officers and F. G. Bennett, The Buckeye Steel Castings Company, Columbus, Ohio; T. H. McKenney, Illinois Steel Company, South Chicago, Ill.; J. E. Culliney, Bethlehem Steel Company, Bethlehem, Pa.; J. M. Woltz, the Youngstown Sheet & Tube Company, Youngstown, Ohio.; John P. Mudd, The Midvale Company, Nicetown, Philadelphia, Pa.; E. R. Rose, Republic Iron & Steel Company, Youngstown, Ohio.

Unusual Safety Record

Of the 27 works of the American Sheet & Tin Plate Company, including the roll and machine works at Canton, Ohio, 13 of them, employing 7,100 men, went through the month of September without a lost-time accident, and five, employing 3,500 men, with only one lost-time accident. It was the second consecutive month at the Gary sheet mill without a lost-time accident, and the eighth consecutive month in which the roll and machine works escaped an injury to any of the 400 employees that caused loss of time.

Reduction in Steel Mill Accident Rate

From the records compiled by the United States Bureau of Labor Statistics there is evident a most decided reduction in accidents since 1907. In the period from 1907 to 1911 the accident frequency rate was 69.2 for each 1,000,000 hours exposure. In the interim between 1922 and 1926 this percentage dropped to 29.9 as an average. In those steel plants where accident prevention has been highly developed the reduction is even greater, since in these plants the rate in 1913 was 60.3 while for 1926 it was only 6.8 for 1,000,000 hours exposure.



John A. Northwood is safety director of the Cambria Plant of the Bethlehem Steel Company and also chairman of the Metals Section of the National Safety Council.

New Safety Head for Carnegie Steel Co.

Joshua F. Hunter, safety inspector at the Homestead steel works of the Carnegie Steel Company, Pittsburgh, since October 1916, has been named general safety inspector of the company to succeed the late Adam W. Slater. He will have headquarters in the general offices, Carnegie Building, Pittsburgh. He attended Lafayette College, graduating in 1906 with the degree of civil engineer. He then entered the service of the Pennsylvania railroad and was assistant supervisor at Columbia, Pa., Camden, N. Y., and Perrysville, Md., resigning in October 1916 to take up safety inspection work at the Homestead steel works.

Publications on Eye Injuries

The National Committee for the Prevention of Blindness, 370 Seventh Avenue, New York, are issuing the following bulletins:

- 1—Eyestrain: What it is, and how to avoid it.
- 2—Infectious Eye Ailments, and how to avoid them.
- 3—Sight-saving hints to the near-sighted and the far-sighted.
- 4—Good lighting in the home.
- 5—First aid for eye injuries.
- 6—Eye Hazards at work and at play: How to guard against them.

The Brier Hill Coke Plant of the Youngstown Sheet & Tube Company has now operated for more than a year without a single lost time accident.

The Blast Furnace *(and)* Steel Plant

Member of the Audit
Bureau of Circulation

PITTSBURGH, PA., DECEMBER, 1927

Entered as second class mailmatter at Pittsburgh,
Pa., under the act of Congress, March 3, 1879.

DEC 10 1927

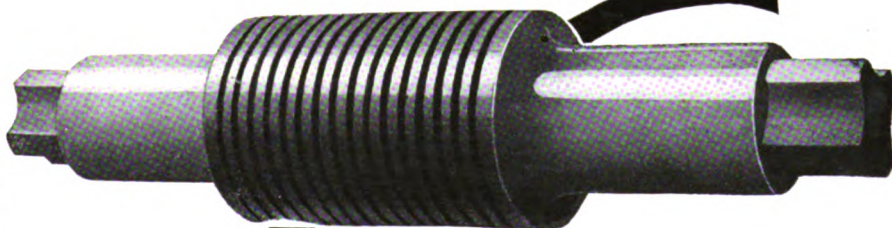
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A performance record made in a rod mill using Chilled Adamite Finishing Rolls, showed an average output of 15,250 tons per dressing. Chilled Iron rolls on same mill gave an average of only 1,850 tons per dressing.

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